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The Delay in Publication

ALTHOUGH the printers' strike in New York City, which has been at a deadlock for seven weeks, is still in force, the situation is so well in hand that no further serious delays are anticipated in the publication of future issues of MARINE ENGINEERING.

When the strike began on September 30, practically all magazine publishers whose printing was being done by union labor in New York City were forced either to suspend publication or have the printing done elsewhere. Many of the publications driven from New York in this way will not return. As a matter of fact, there is no intention on the part of the publishers to compromise with the radical element in the printing industry which is at the bottom of these labor disturbances.

Behind this outbreak can be found the same sinister influence that first in Russia, later in Germany, and now in America, is seeking to overthrow industry and establish mob rule. It is fostered by a class that violates contracts, repudiates agreements, refuses arbitration, defies its national labor organization and is a direct menace to the law and order of the land. In taking an unswerving stand against this element at whatever cost, the publishers are showing their loyalty to the United States and deserve the undivided support of their clients.

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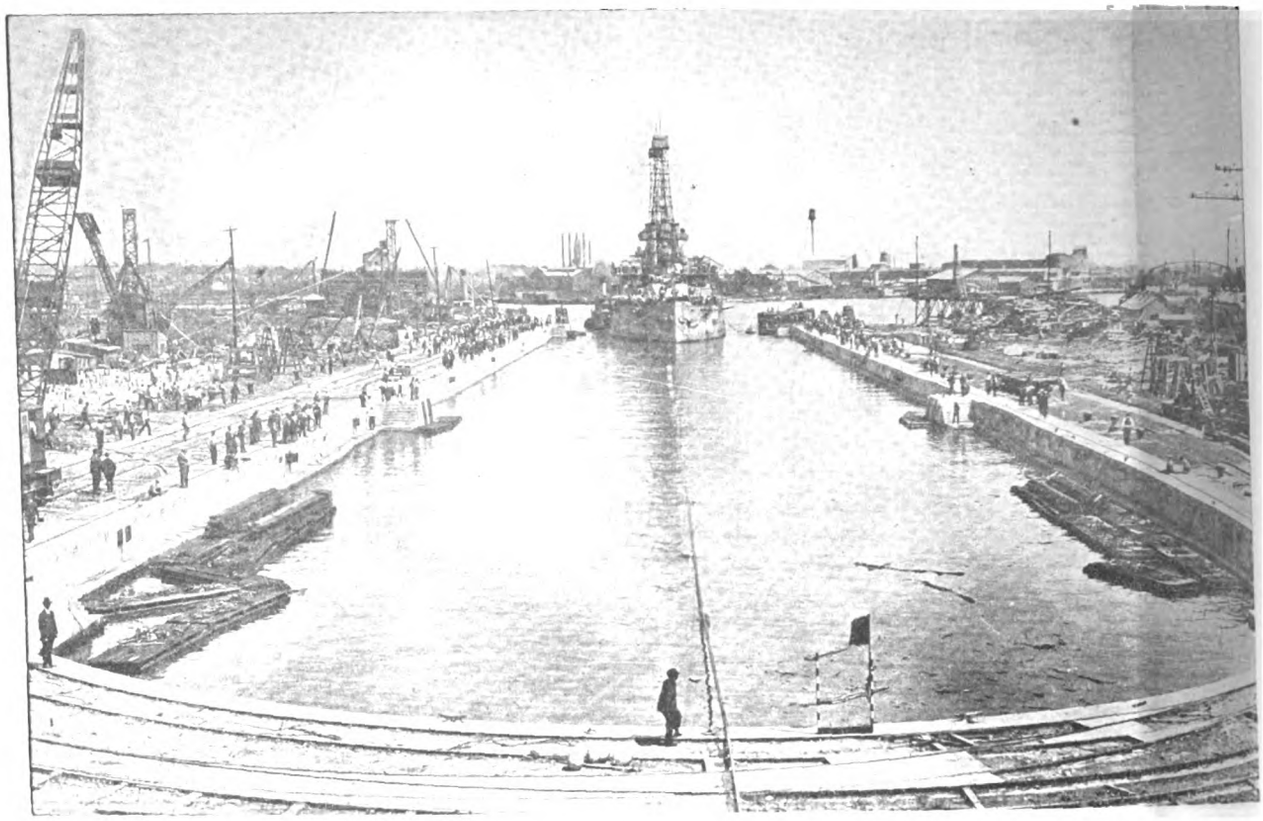

Fig. 1.—One of the Six Drydocks in the Norfolk Navy Yard

The Use of Acetylene in Navy Yards

Oxy-Acetylene Apparatus for Welding and Cutting Proves Indispensable in the Building and Repairing of Ships and Other Manufacturing Processes

BY COMMANDER H. G. KNOX, U. S. N.†

NAVY yards use acetylene very generally and in large amounts for perhaps a greater variety of purposes than do any other industrial concerns. To show that acetylene played an important part in navy yards in winning the war, the following monthly consumption of acetylene at some of the navy yards is interesting:

New York used about 110,000 cubic feet per month; Charleston, 15,000 cubic feet; Norfolk, 60,000 cubic feet; Boston, 75,000 cubic feet.

While one is apt to think of oxy-acetylene as a means of welding, it happens that in navy yards probably more acetylene is used in cutting than in welding. The war demanded of navy yards (working in many cases a 10- or 12-hour day) the reconstruction of hundreds of ships from the pursuits of peace to the transport of troops and the cargo carrying of war. Every time a passenger or cargo vessel is converted into a transport many changes are necessary. Bulkheads must be cut out or moved; ventilation must be installed; plumbing, berthing and messing fixtures must be manufactured and put in place. During the war, time was the primary consideration; money the secondary one. The acetylene torch cut its way through all obstructions and provided a quick and easily transportable means of accomplishing the desired end. Hundreds of cutters were employed day and night. Ships were converted, refitted and quickly sent on their way carrying the troops which at the vital moment perhaps turned the tide of war.

Extensive Use of Cutting Torch

Not only were ships already in existence made over,

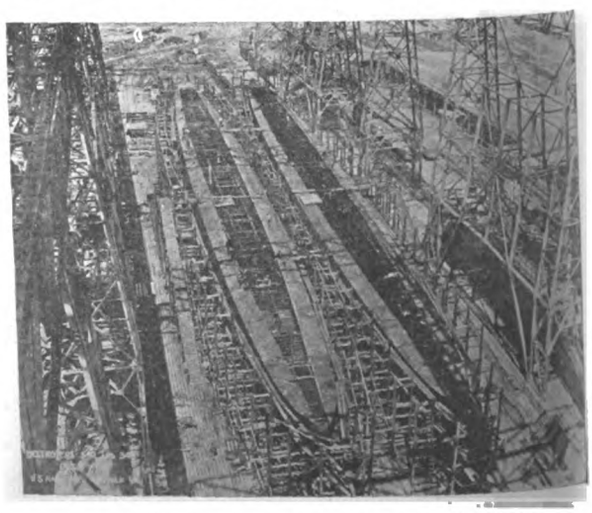

Fig. 2.—Two Destroyers in Building Slip

*Paper read at Annual Convention International Acetylene Association, New York, July 15, 1919.

†Construction Corps, United States Navy.

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Fig. 3.—Structural Steel Shop at Norfolk Navy Yard

but new construction in private yards, in new shipyards and in navy yards was rushed to the limit. Practically every plate and shape involved in ship construction, both merchant and man-of-war, requires cutting to a greater or less extent to insure fitting for passage of pipes, for access doors and hatches, etc. But the portability of the gas cutting torch the tool is taken to the work rather than the work to the tool. Fig. 9 shows the heat effect around a cut.

In the field of armor cutting (and there are thousands of tons of armor in modern ships) the gas torch, of course, holds entire sway. Hydrogen here assists acetylene in the heavier cuts.

Many ingenious mechanical devices for guiding the torch have been developed, and with these a cut approaching in cleanness the cut of a power-driven tool is obtainable. On account of the cleanness of cut (Fig. 10), the gas torch is, of course, always preferred to the carbon arc.

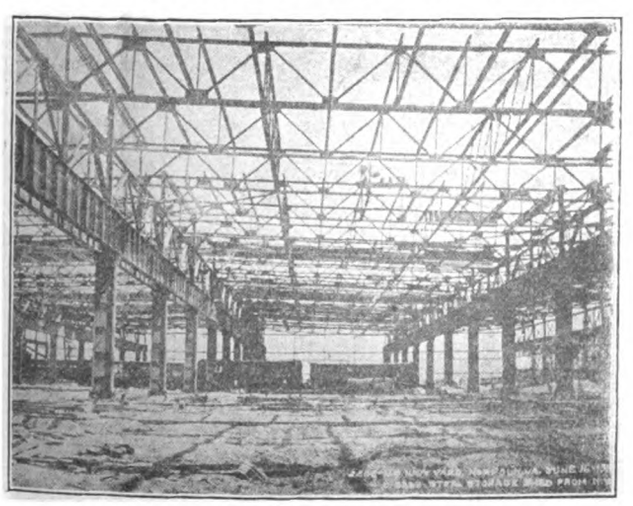

Fig. 4.—Structural Steel Storage Yard

SHIP REPAIRS FACILITATED BY THE GAS TORCH

Not only were ships built during the war, but the navy yards were many times called upon for emergency repairs, often so extensive as to involve the rebuilding of an entire section of a ship. At New York the work on the *Texas, Huntington, Olympia* and *Æolus* would have been many weeks delayed without the gas torch. Boston did similar excellent work on the *Mount Vernon, America* and *Covington,* also in converting the *Shawmut* and *Aroostook* into mine layers. At Philadelphia the replacement of the whole forward end of a battleship which received the full impact of a mine explosion could never have been done in the required time in which it was accomplished without this fiery assistant. Boston had a like job on the torpedoed *Mount Vernon.*

When we come to the field of gas welding, navy yards do not differ, except in the variety of their work, from many of the other shops. It is only necessary to remember that every metal working trade—and that represents nearly every metal trade in extistence—at one time or another falls back on welding. The electric arc has an important place in the welding of structural steel and steel castings and forgings; but, nevertheless, acetylene is also extensively employed in this class of work. It is our belief that the gas weld responds to annealing or other heat treating much better than does the arc weld.

ANGLESMITH WORK NOW DONE BY GAS ARC WELDER

Sea water is most unfriendly in its disposition towards steel. It therefore becomes necessary in ships to use non-corrodible metal in hundreds of places where steel or iron might otherwise be used. While the welding by electric arc of the non-ferrous alloys is undoubtedly possible and

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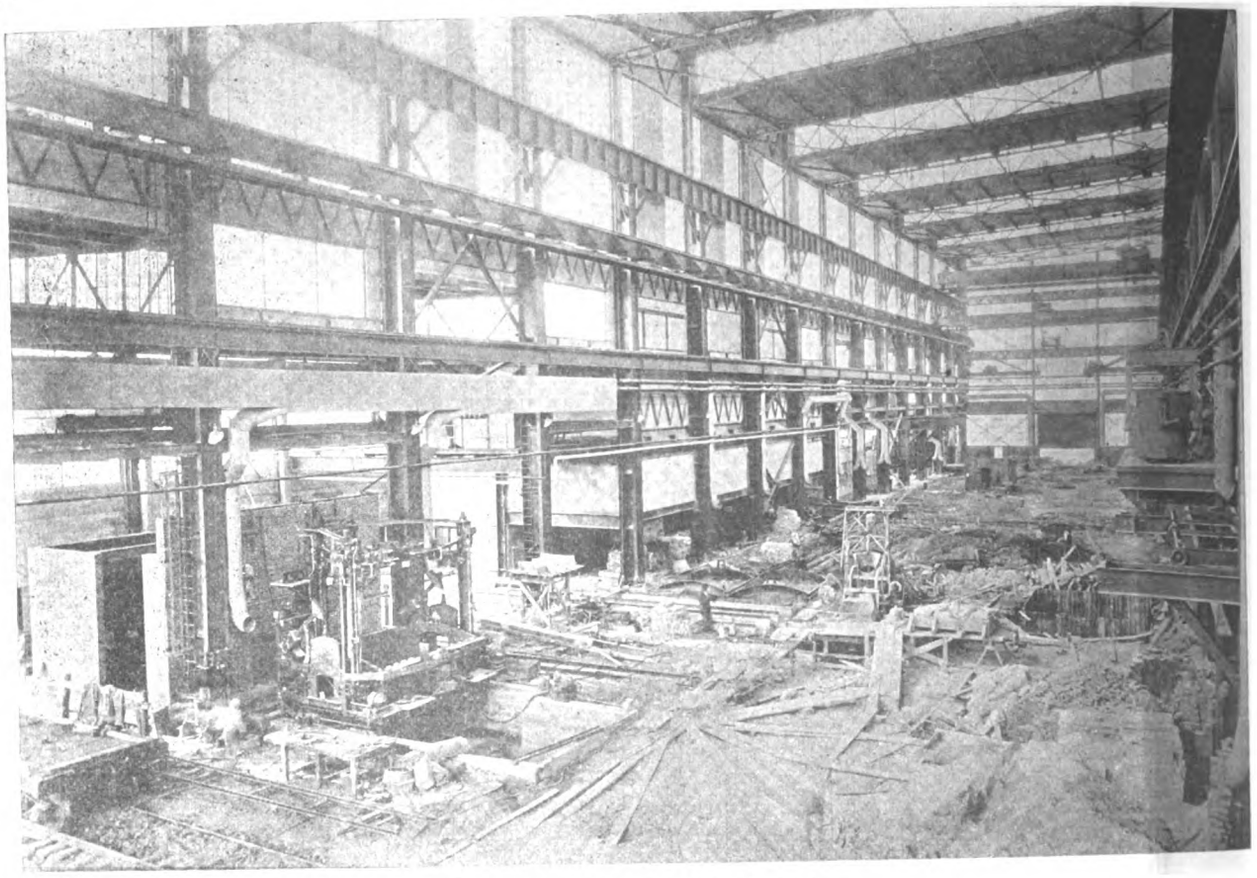

Fig. 5.—Foundry at Norfolk Navy Yard

may some day be extensively used, the use of the oxy-acetylene torch for this work up to the present has been practically universal.

The welding of angle bars (Fig. 12) and, in fact, all of the shapes used in ship construction, heretofore done by the blacksmith, is rapidly being taken over by the gas arc welder, and fittings built up out of scraps of plates, shapes, pipes, etc., are everywhere in evidence. The cost of the gas-welded article is very much less than when made by the smith. The entire drainage system, including most of the fittings of the three destroyers now being completed at Norfolk, were made by welding scraps of steel together, thereby eliminating castings. The welding of pipe (Fig. 13) and pipe fittings offers a wide field for ingenuity. Flanged elbows may be made by filling steel tubing with sand and making four close right-angle bends. When cut apart, scrap steel flanges are welded on to complete the elbows. Tees, crosses, deck and bulkhead fittings are likewise readily made up.

The brasses and bronzes used in such a variety of mixtures aboard ship (Fig. 14) are all more successfully welded or built up with the oxy-acetylene torch than by any other method. One of the most frequent callers for repairs are propellers (Fig. 15). New tips, new edges, and in some cases practically entire blades, are recast

Fig. 6.—Cutting Scrap at Norfolk Navy Yard

Fig. 7.—Cutting a 12-Inch Billet With Oxy-Acetylene Blowpipe

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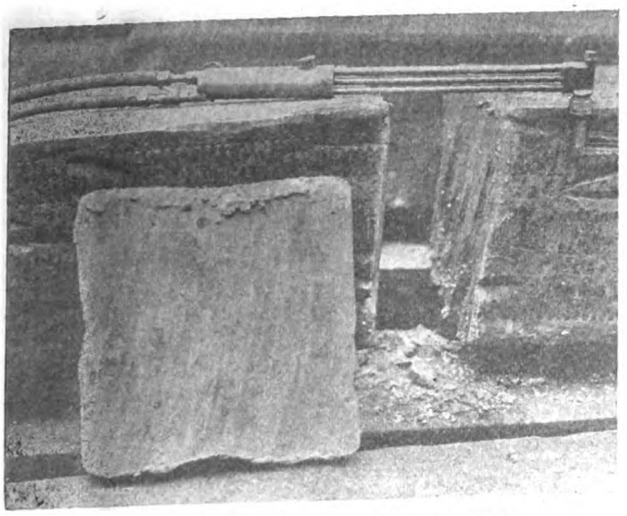

Fig. 8.—Section Cut from 12-Inch Billet

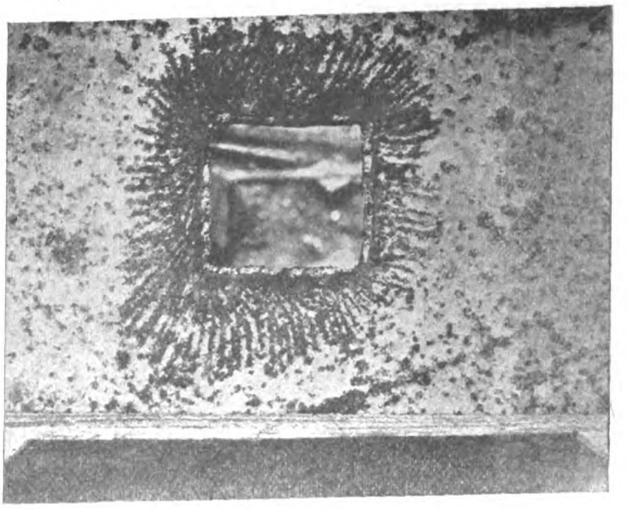

Fig. 9.—Interior Cut Made by Oxy-Acetylene Blowpipe

from manganese bronze and welded on successfully. Fittings for submarines (Fig. 16) also come in for their share of welding, and these must not only be strong but tight. Portsmouth, N. H., specializes in submarine con-

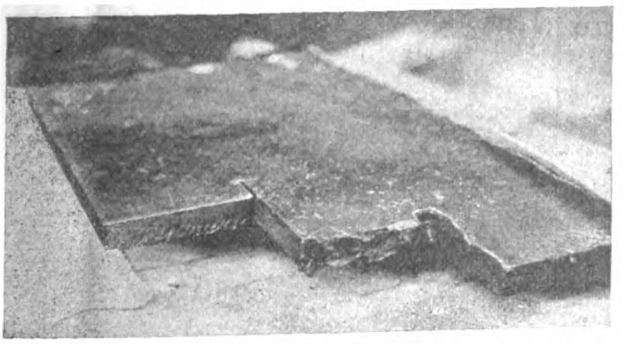

Fig. 10.—Showing Superiority of Oxy-Acetylene Cutting (at Left) Over Cutting by Carbon Arc (at Right)

struction, and frequently has to weld large manganese bronze castings for these undersea craft. Bell metal also occasionally fails, but the breaks are easily gas welded.

In addition to manganese bronze and bell metal, we also

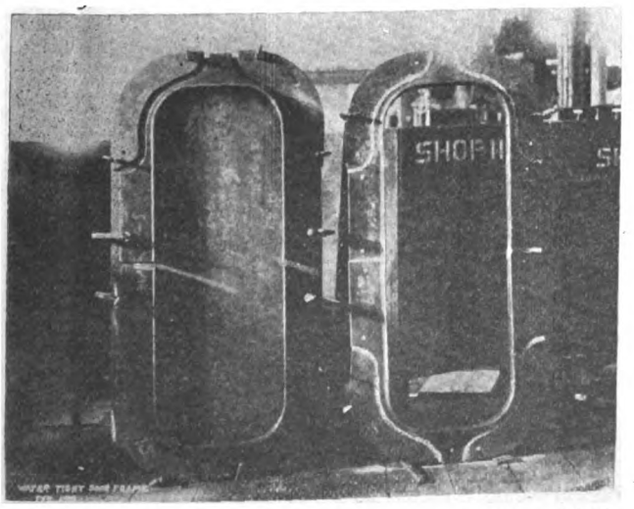

Fig. 11.—(On Right) Watertight Door Frame Made by Welding Together Pieces of Angles and Plating. (On Left) Parts Clamped in Position Before Welding

encounter in large quantities gun metal, valve bronze, journal bronze, naval brass, muntz metal, phosphor bronze, and last, but not least, pure copper. Under intelligent operation the gas welding of copper may some day almost completely supplant the coppersmith's art of brazing. Naval rolled brass is the favorite filling material for copper and most of the other brasses and bronzes. Samples of copper pipe made up out of 5/16-inch sheet copper have been hydrostatically tested to destruction, and the welded seams compared very favorably with brazed seams.

METALS THAT CAN BE WELDED WITH ACETYLENE

Cast iron is also welded more reliably with oxy-acetylene than with the electric arc. There are times when, due to the complexity of a casting, the arc rather than gas may be more conveniently used. The use of carbon blocks

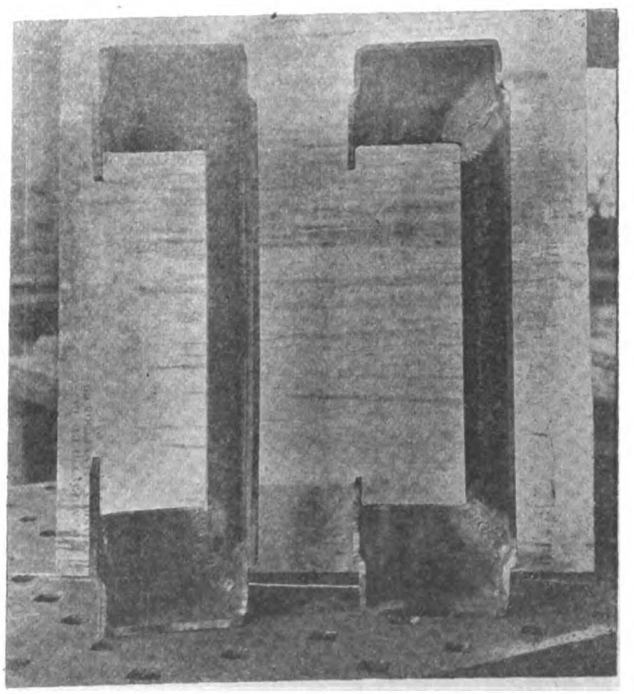

Fig. 12.—Specimen of Oxy-Acetylene Cutting and Welding as Applied to the Manufacture of Bulkhead Stapling Between Deck Beams. Joggles Made Under Hydraulic Press Where Possible

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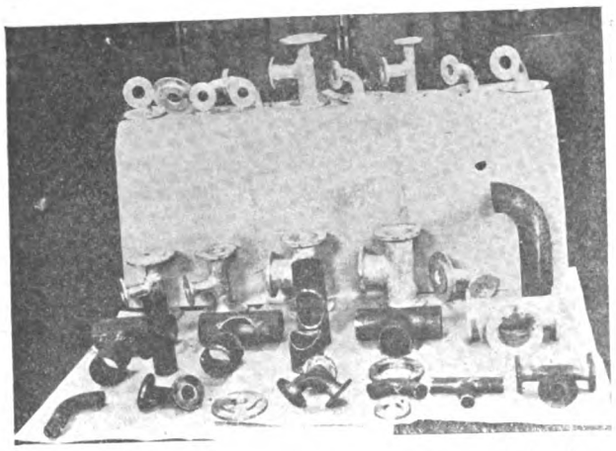

Fig. 13.—Steel Fittings Made Out of Scrap Tubing by Oxy-Acetylene Welding

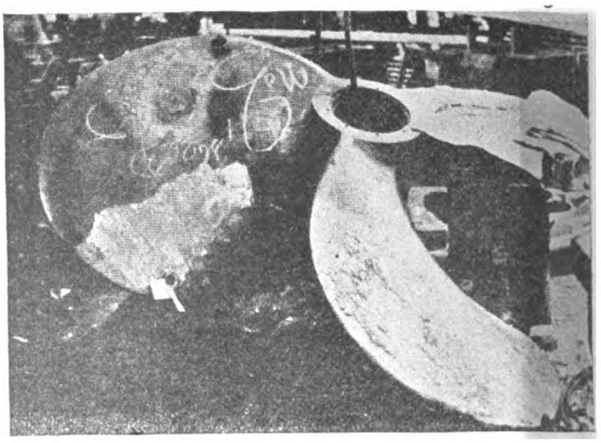

Fig. 14.—Filling Shrink Holes in Manganese Bronze Propeller With Aid of Oxy-Acetylene Blowpipe

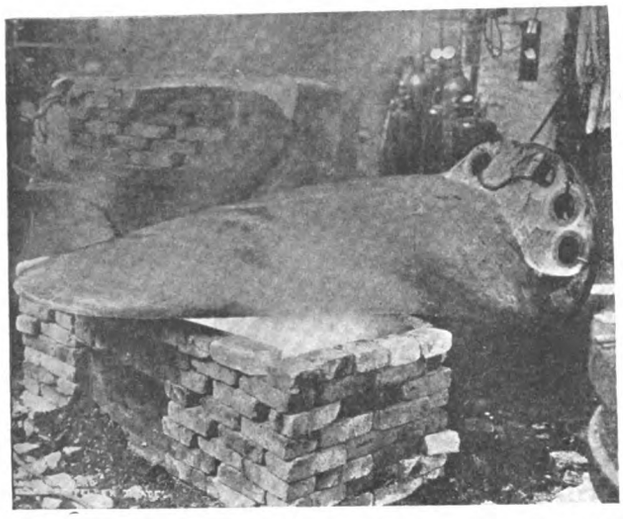

Fig. 15.—New Tip Placed on Manganese Bronze Propeller Blade by Oxy-Acetylene Process

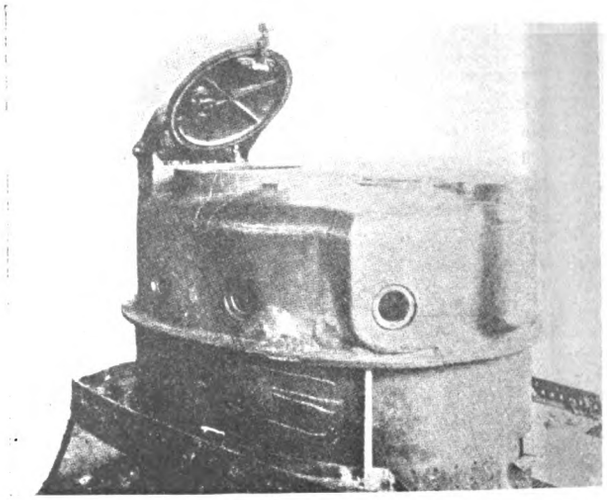

Fig. 16.—Small Holes in Manganese Bronze Casting on Submarine Oxy-Acetylene Welded. Casting Subjected to 88 Pounds Water Pressure

and carbon paste, of course, greatly extends the field of the gas torch in difficult jobs, and these aids are freely used. The preheating of a complicated iron casting is often not permissible, and a "cold" weld is more common with the arc than with gas. Gas, however, more than holds its own in the special field of cast iron.

Fig. 17.—Upper Flange of Neckar's Port First Intermediate Cylinder Welded

Fig. 18.—Starboard Low-Pressure Cylinder of the Rhein Welded

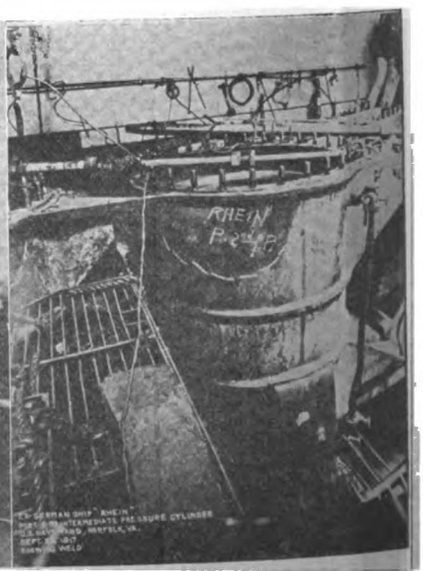

Fig. 19.—Port Second Intermediate Cylinder of the Rhein Welded

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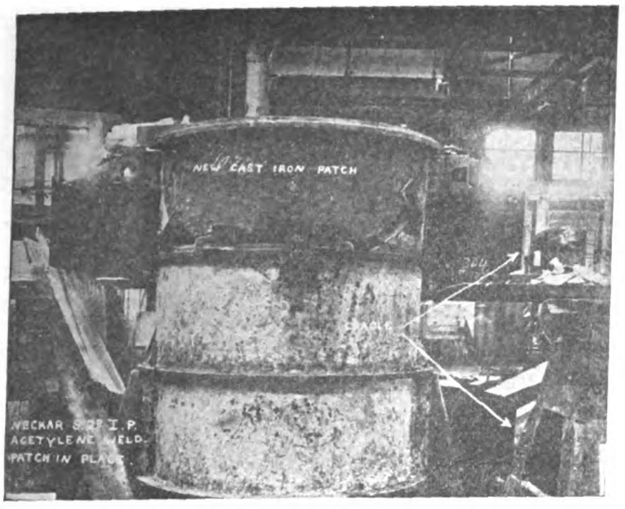

Fig. 20.—Patch in Place for Welding on One of the Neckar's Cylinders

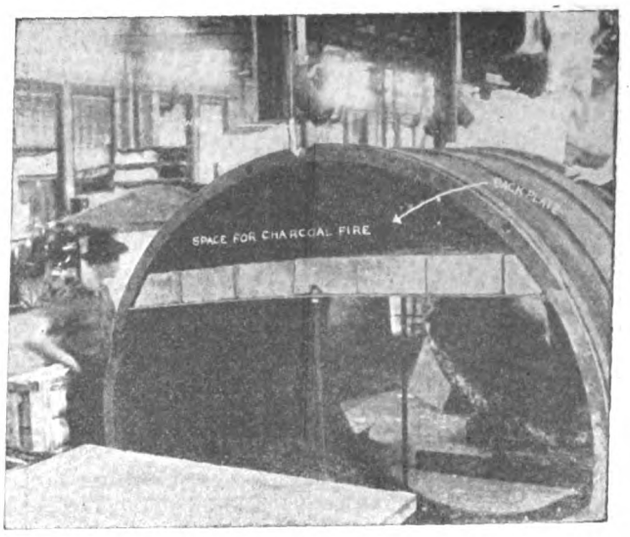

Fig. 21.—Arrangement for Preheating Liner Before Welding

Much has been said about the salvaging of the main engine cylinders of the German ships at various navy yards, particularly the New York navy yard. The repairs to engines effected by welding on those ships undoubtedly is one of the most spectacular feats of the war. At New York all of the welds were made with the electric arc, as were a few at Philadelphia, Boston and Norfolk. As far as I am aware, all of the welds made on these cylinders have stood up perfectly in service.

Damaged Engines of German Ships Repaired by Gas Welding

At Norfolk three German ships were delivered for repair—the *Rhein, Neckar* and *Bulgaria*. The major portion of the welds on the damaged cylinders of these ships were made by oxy-acetylene. The only bad break on the *Bulgaria* was repaired by electric arc. On the*Rhein* and *Neckar,* however, all of the major welds were made with gas. Six of the *Rhein's* eight cylinders were gas welded six of the *Neckar's* eight cylinders were also gas welded. (Figs. 17-19).

One important point in comparing gas and arc welds in cast iron that was brought out by the big cylinder job is the superior machining of the gas weld. A welded cylinder liner, for example, machined with no trace of hardness at the cleavage line between parent metal and filler. This was seldom the case with the arc welds where machining was required. To this extent the gas weld is superior.

Except for the size of the welds and the importance of the jobs, no special features of interest developed in the welding. Patches were made of cast iron (Fig. 20) and the patch and cylinder after clamping together were preheated with charcoal fires (Fig. 21) for several hours before welding started. In order that the puddled metal of the weld might be kept horizontal, and thereby facilitate the welding, the cylinders were carried in cradles or rockers, so that they could be rotated.

While ship work represents the principal activity of the navy yard, yet most of the navy yards carry on considerable strictly manufacturing work. A few of the yards have developed specialties in many fields.

Specialized Branches of Manufacturing

At Norfolk, for example, no less than 26,500 rectangular pipe bunks for transports were welded during the war. Nine thousand gasoline (petrol) tanks for motor boats were also turned out during the same period. The longitudinal seams of these tanks were mechanically welded on a "barrel welder." Norfolk also manufactured over 200,000 packing boxes for the Bureau of Ordnance. These airtight boxes are used for the transportation of smokeless powder from the factories where the charges are made up. The nozzles were welded to the tops of these boxes by oxy-acetylene on a piece-work basis.

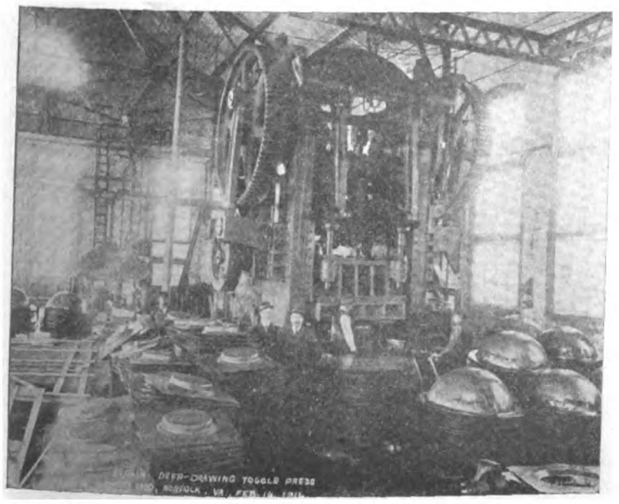

Fig. 22.—Drawing Press for Making Mine Hemispheres

Fig. 23.—Welding 10-Foot Equator Seam of Mine

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The biggest single war-time job of a manufacturing nature undertaken at Norfolk was the manufacture of nearly 15,000 naval defense mines (Fig. 24). Except for certain minor castings and assemblies, the work was done entirely at the navy yard. A large double-acting drawing press (Fig. 22) more than paid for itself on this job alone. Each of these mine spheres involves a 10-foot gas weld at the equator seam. Ten to twenty men were employed continuously on this work.

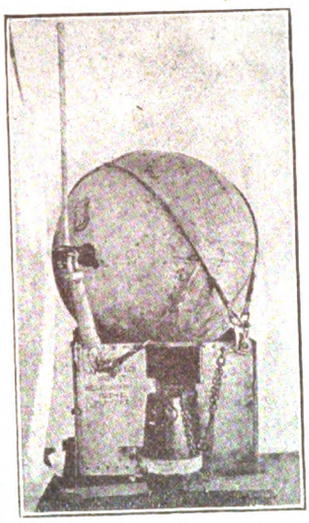

Fig. 24.—Completely Assembled Mine and Anchor

A use for acetylene in navy yards, which is out of the ordinary, is its availability for the local heating of structural plates and other members, particularly when damaged by collision. It is often necessary to straighten plates or remove bumps, and the quick local heating of such work is done, although perhaps not economically, by acetylene. During the war many vessels were fitted with underwater mine sweeping devices, and the shaping and bending of plates by acetylene for this work was quite common.

One more use for acetylene may be mentioned, although it is not general; this is lighting. Some of the navy yards during the war on more than one occasion fell back upon portable acetylene lighting equipments for their emergency work in the bottom of dry docks or other places where electric flood lamps could not readily be installed.

Most of the navy yards are equipped with their own gas generating plants. Few of the yards are, however, self-supporting, and they are therefore dependent on outside concerns for making up the deficiency.

Immediately after an unfortunate accident in the gas generating plant at Norfolk in May of this year, the writer had the privilege of visiting two or three of the largest gas plants in the country, and as a result prepared a type plan of gas generating plant for navy yard use as shown in Fig. 25. After modification in Washington and approval, it is probable that this plan will be adopted for the navy yard gas plants built in the future.

Type Plan of Gas Generating Plant

In this layout an attempt was made to separate the various gases, and in the case of acetylene the various stages of production, from generation to storage of gas in tanks. This plan also contemplates the piping of acetylene at about 12 pounds pressure to all the shops in the vicinity of the centrally located gas plant. In this way the high-pressure compression of much gas can be avoided, as well as the transportation of gas tanks. This method has already proved very efficient in many yards. Oxygen and hydrogen are likewise piped to manifolds at convenient points on the shop walls.

An innovation recently started at the Norfolk yard is the establishment of a welding shop. This does not mean that the welding shop will control or perform all welding work, but it will be the headquarters for welding and cutting equipment and trained operators. This shop will, however, do all the job welding on castings and other work removed from ships for repair. The welding shop furnishes trained men to other shops on permanent or temporary details, often in large numbers. By concentrating the work in one shop under a single foreman, it is possible to control the technique of welding better and at the same time accomplish the maximum of work with the minimum force.

Welding Shop Equipment

The equipment of this shop includes a complete gas cutting and welding outfit, as well as fixed and portable arc welding equipment. This shop furnishes all the electrode and filling material, protective devices, and, in fact, all of the adjuncts necessary to welding.

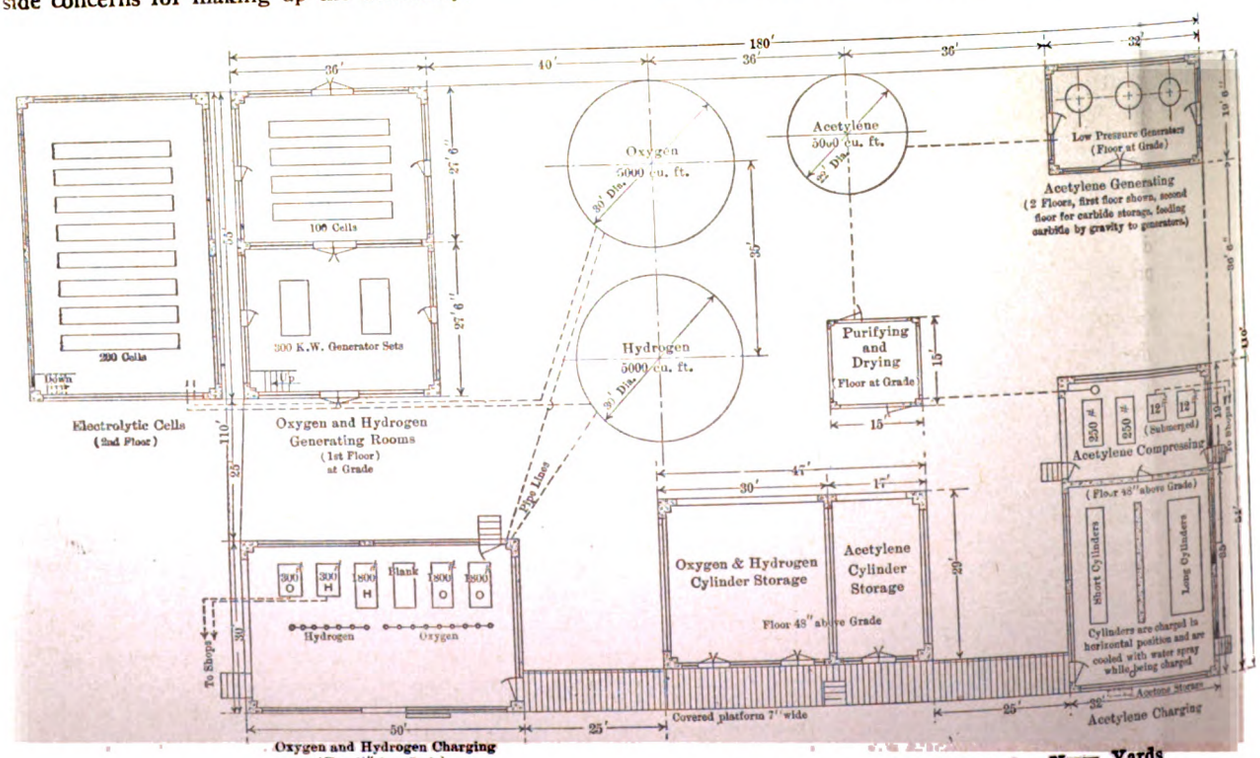

Fig. 25.—Typical Plan of an Oxygen, Hydrogen and Acetylene Generating Plant for Navy Yards

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In the increase of the welding activities it became impossible during the war to obtain trained welders. At the Norfolk navy yard we therefore undertook the training of our own men, and the school now established, which works in connection with the welding shop, not only supplies our trained operators, but is also the central training point for operators from the other east coast navy yards. By giving students not only practical work but lectures on the properties of metals, the expansions and contractions encountered in welding, and kindred subjects, we endeavor to turn out students who, after they have spent a few months in practical work outside, can at any time be called upon to face the variety of problems which are, with us, an everyday occurrence.

Oxy-Acetylene Welding in Hull Construction

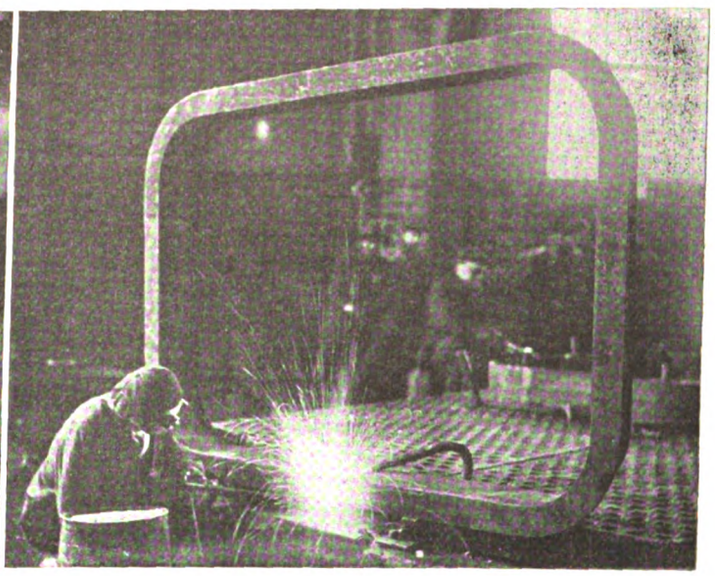
Parts of a Vessel Which May Be Welded With the Approval of the Principal Ship Classification Societies in the United States and Great Britain

BY CHARLES C. PHELPS*

ONE beneficial effect of the world war has been its modernizing influence on industry. American shipbuilding, in particular, has felt this influence strongly during its phenomenal growth from infancy to adultness within the interval of a few months.

One of the modern industrial aids that came to be fully appreciated in shipyards during this period was the oxy-acetylene process.

Filling Up Punched Holes in Plating by Means of an Oxy-Acetylene Blowpipe and Steel Filling Rod



Welding Butt of Door Frame With Oxy-Acetylene Blowpipe

OXY-ACETYLENE CUTTING DEVELOPMENTS

Before the war the oxy-acetylene cutting process (or, as it is sometimes erroneously called, the "burning" process) had been employed very extensively in shipbuilding—in fact, it had actually revolutionized many shipbuilding operations. Perhaps it is natural that the cutting process should have been adopted initially to a greater extent than the welding process, inasmuch as it solved many difficult shipbuilding problems without introducing any new ones in its application.

Let us pause to review some of the advantages of the oxy-acetylene cutting process. It makes a clean cut and does not injure the metal in the least. It does cutting that is extremely difficult by any other method—for instance, cutting shafts, H-bars, I-beams, columns, steel castings, thick plates, and notches and inside curves in plates. The tool is brought to the work, thus eliminating much heavy lifting by cranes, with all its attendant hazards and delays, and reducing the amount of shop work. Much of the cutting is now postponed until the parts are erected on the hull framework and some is even delayed until the hull is nearing completion; this insures openings in the right places, better fitting and often contributes to the safety of operations in general. It is extremely easy to figure the savings in cost and time secured by substituting blowpipe cutting for shearing, sawing, punching and drilling.

It is probable that even to-day from two-thirds to three-quarters of the acetylene force of the average shipyard is engaged in cutting work, the remainder doing principally welding work.

VALUE OF OXY-ACETYLENE WELDING APPRECIATED BY SHIPBUILDERS

Much more oxy-acetylene welding work has been employed in ship construction in Great Britain than in the United States, due to the fact that this country is more or less young in quantity production of ships.

The development of welding in shipbuliding has been retarded in this country not only by the scarcity of trained

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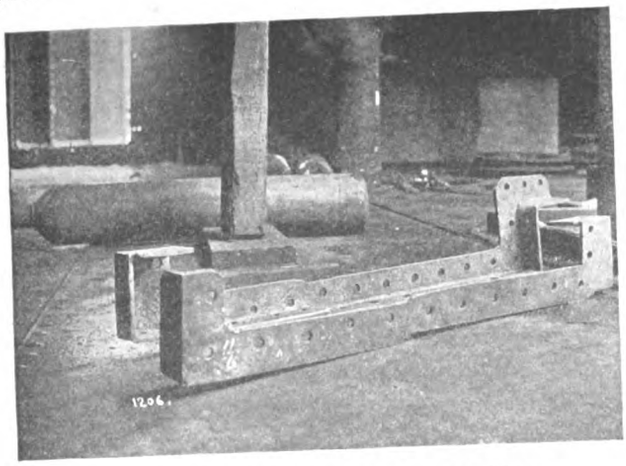
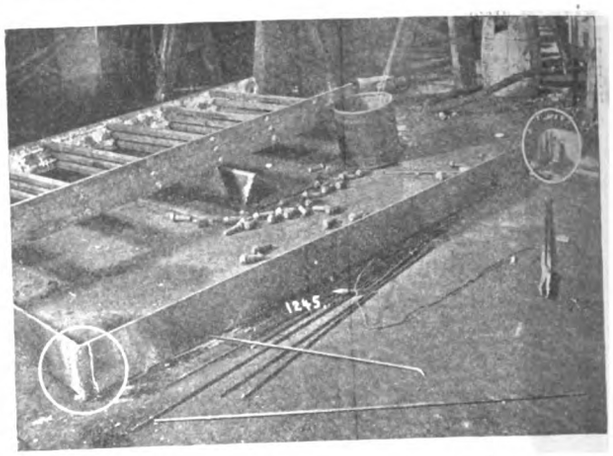


Staples Made by Oxy-Acetylene Welding



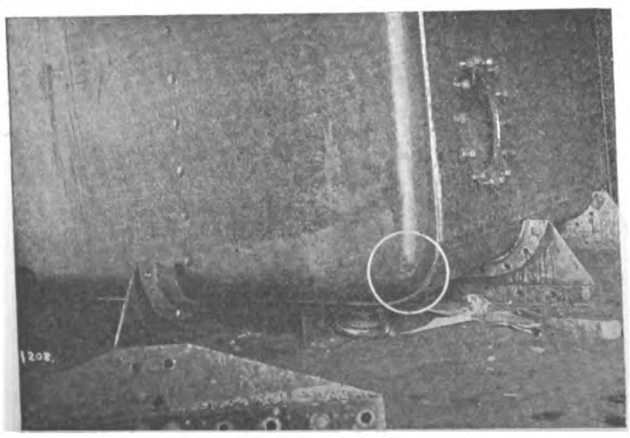
Partition Base Corners Oxwelded

welders, but also by uncertainties as to ways to apply welding to specific work in order to obtain efficient results. Sometimes welding necessitates a change—usually a simplification—of the design of the parts to be joined and changes from accustomed practice always involve more or less overcoming of inertia. Experience is gradually teaching the best ways of applying welding and removing doubts as to the efficiency and economy of oxy-acetylene welded joints. Reliable tests made by various technical institutions have shown conclusively that an oxy-acetylene weld made according to present standard practice compares more than favorably with other forms of joint.

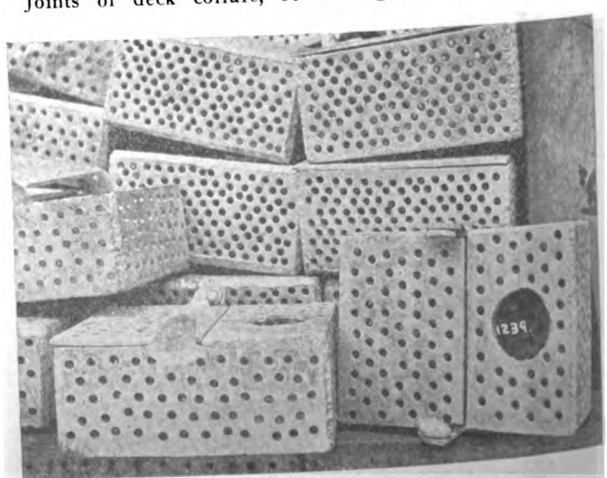
Classification Societies Approve Oxy-Acetylene Welding

With quantity production during the war the attention of shipbuilding circles was focussed on the value of oxy-acetylene welding. This fact is reflected in the recent action of such conservative bodies as Lloyd's Register of Shipping and the American Bureau of Shipping in issuing instructions to their surveyors to approve, after the hammer test, certain specific ship parts welded by the oxy-acetylene process. The surveyors of these societies had been approving a great deal of welded work for a long time, and they were still inspecting and passing, piece by piece, many parts not on the official list; but it was a step in advance when the American Bureau of Shipping took action last August by issuing the following list of parts on which oxy-acetylene welding is permitted:

Deck rail stanchions to plating.
Clips for detachable rail stanchions.
Continuous railing rods (joints).
Attaching deck collars (L rings) around ventilators.
Attaching deck collars (L rings) around smoke stacks.
Attaching cape rings around smoke stacks, pipes, etc.
Attaching galley fixtures to plating.
Attaching bath and other fixtures in officers' quarters.
Attaching cowl supporting rings to ventilators.
Bulwark rail top splicing and end fitting.
Skylights over galley.
(a) Engine room stairs and gratings.
(b) Boiler room stairs and gratings.
Attaching (a) and (b) to plating grab rods of casing.
All stairs and ladders, including rail attachments.
Door frames to casings, hinges, catches hold, coach-hooks, etc.
Clips for attaching interior wood finish to casing.
Entire screen bulkhead.
Coal chutes.
Butts of watertight and oiltight bounding bars on bulkheads or floors in double bottom.
Ventilator cowls.
Stacks and uptakes.
Bulkheads (that are not structural parts of the ship). Partition bulkheads in accommodation.
Framing and supports for engine and boiler room flooring or gratings.
Cargo batten cleats.
Tanks (that are not structural parts).
Shaft alley escapes.
Steel skylights over accommodation spaces.
Engine room skylights.
Grab rods on exterior and interior of deck houses.
Deck houses not covering unprotected openings through weather decks.
Reinforcing and protecting angles around manholes.
Joints of watertight angle collars at frames in way of watertight flats.
Joints of deck collars, reinforcing and protecting angles.



Fresh Water Tank With Rounded Corners Oxy-Acetylene Welded



Strainer Boxes Gas-Welded and Galvanized

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watertight angle collars at frames in way of watertight flats, etc., and all other welds which cannot be tested satisfactorily after installation are to be welded and tested prior to installation.

Lloyd's Register of Shipping also approved the list identically as printed above on September 5, 1919.

Although the above list includes many of the more common applications, it does not begin to give an idea of the extent to which the process has been adopted in ship construction. Hundreds of other parts have been welded and have passed inspection. A few of these additional parts that are commonly welded are staples, hatch cover frames, hatch coaming corners, wash plates, crow's nest frames, davits, ash ejectors, partitions for gas-tight compartments, seams in steel masts, piping, filling up misplaced punched holes, and as a substitute for calking under certain conditions.

The welding torch is also used extensively for local heating, such as for heating the heads of rivets that have become loose so that they may be drawn up tight and for heating plates and other structural members, so that they may be shaped for a perfect fit.

WHY SHIPBUILDERS ADOPT OXY-ACETYLENE WELDING

Whether in a given case oxy-acetylene welding should be substituted for riveting, screw-jointing, bolting, calking or a combination of these processes depends upon a consideration of the various factors involved. Welding will frequently win out on a mere comparative first cost basis, but will often make a still better showing by its reduction of maintenance expense, by producing absolute water- or oil-tightness, by avoiding the necessity of liners or packing, by eliminating gaskets and flanges in pipe work, by avoiding drilling, reaming, grinding and fitting, or by simplifying the design of interdependent parts.

In conclusion, some of the objects to which oxy-acetylene welding has been applied in other fields will be cited; these clearly indicate the reliability, efficiency and safety of the process; ammonia containers of refrigerating systems, which are subjected to extremes of temperature; compressed air receivers and compressed gas containers; Liberty motors and many airplane parts, the failure of which would endanger aviators' lives; steam pipe lines, which are subjected to extremes of temperature and pressure; poison gas containers used in chemical warfare, the failure of which would almost surely lead to disastrous consequences; marine buoys, which must resist the corrosive action of the salt water, and serve faithfully as sentinels to warn the mariner; various locomotive parts, the repair of which forms one of the most extensive applications of the process, and chemical plant installations, which involve almost all possible physical and chemical extremes.

Those who know the oxy-acetylene process best have most confidence in it. So far as the quality alone of oxy-acetylene welds is concerned, there is no reason why they should not be applied to making almost any kinds of joints, as indicated by the present broad field of application. The sole remaining questions to be decided in each case are those involving expediency and relative costs, and these cannot be settled until all the factors entering into the case are taken into consideration.

An Analysis of Stresses in Bulkhead Stiffeners
(Bracketed End Connections)

BY SPECIAL CORRESPONDENT

IN a former article the stresses in clipped and free-ended bulkhead stiffeners were determined for a given bulkhead designed in accordance with the rules of one of the classification societies. It was shown that the stresses were all very high except in the case of deep tank or peak tank stiffeners.

In this article it is intended to arrive at the stresses in a corresponding set of stiffeners, if the ends are sufficiently bracketed, and also to arrive at the stresses in the rivets of the bracketed connection.

The largest factor of uncertainty in this calculation is the degree of end fixing that the bracket is capable of. Professor Hovgaard, in his classic papers on bulkhead stiffeners presented before the Society of Naval Architects and Marine Engineers some years ago, assumes that the brackets fix the ends of the stiffeners absolutely—that is, of course, if properly designed and the stresses in the stiffeners are below the elastic limit of the material. From a comparison of results obtained on tests, this assumption appears justifiable. Mr. A. Murray, in his book "Strength of Ships," assumes an end fixing coefficient for the brackets varying anywhere from 0 percent to 60 percent. His results, to the writer's knowledge, have never been compared with experimental data. In view of the practical proof of the correctness, and the sound theoretical foundation of Professor Hovgaard's figures, it is believed justifiable to accept his conclusions in their entirety. The following data, therefore, are figured on this basis.

The greatest bending moment in a stiffener fixed with a good bracket at top and bottom is, when subjected to a uniform load in foot units,

$$M = \frac{1}{12} Wl,$$

where W is the entire load carried, i. e., $W = w\,l$, where w is the load per foot and l = length in feet.

This bending moment is at the ends. The moment at the center of the stiffener would only be

$$M = \frac{1}{24} Wl;$$

that is, it is equal to half the greatest moment. Another thing to note is that this latter moment is positive, while the former is negative. The curve of bending moment changes slope very rapidly, and at points near the top and bottom the moment curve crosses the base line, and, of course, at these points is zero. Hence, if the brackets at the ends of the stiffeners are of any length at all, we find that the greatest moment the stiffener will be called upon to resist is $1/24\ Wl$. To obtain this result it is only necessary to make the depth of the brackets about 1/10 of the length of the stiffener from top to heel. This is illustrated in Fig. 1.

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The introduction of the uniformly varying load due to hydrostatic pressure alters the above argument but little in regard to brackets. However, the term for the bending moments would be more involved, due to head and the varying pressure, but still for all practical purposes it

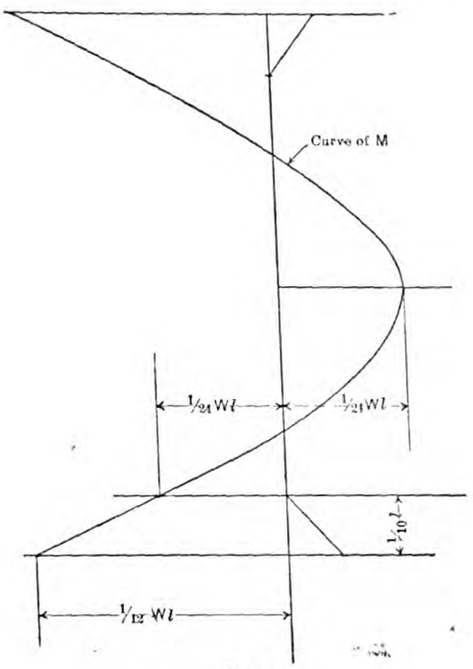

Fig. 1

would be sufficiently accurate to take this moment as $1/24\ Wl$.

A form which lends itself most readily to calculations of this character is that given by Professor Hovgaard, which is

$$M = \frac{Pl}{24} \text{ foot tons,}$$

where

$$P = \frac{s}{35}\left(h + \frac{l}{2}\right) l \text{ tons.}$$

Where, again,

P = load on stiffener in tons.
s = spacing of stiffeners in feet.
h = head of water above top of stiffeners in feet.
l = length of stiffeners in feet.

As in the former article by the author on stresses in bulkhead stiffeners, two general types of bulkheads will be considered, i. e., ordinary watertight bulkheads and deep or peak tank bulkheads. The former type is usually subdivided into cargo vessel and passenger vessel bulkheads. The stresses in these various types, as determined from the rules of one of the classification societies, will be found and discussed below.

The following data are assumed, all as shown on Fig. 2:

1. Length, heel to top, is 12 feet 0 inches.
2. Head, above top to load waterline, is 6 feet 6 inches.
3. Head, above top to bulkhead deck, is 8 feet 0 inches.
4. Spacing of stiffeners, heel to heel, is 27 inches.

The stiffener for this bulkhead, as required by the rules, is a 5½-inch by 3-inch by, 11.9-pound bulb angle.

The mean thickness of plating would be about 0.30 inch.

As in the former paper, the functional strip of plating, i. e., that portion of the bulkhead plating which acts as an integral part of the stiffener, will be taken as thirty times the thickness, or, in this case, nine inches wide.

Following the same general method of calculation as before, we find the total section modulus, i. e., stiffener and plating combined, as follows:

Name	Area, Inches	Distance of C. G. from Bulb of Angle, Inches	Moment, Inches
Plating	2.70	5.65	15.25
Stiffener	3.51	3.15	11.06
Total	6.21	4.24	26.31

Moment of inertia of plate about its own axis is $I = 1/12\ Ad^2 = 1/12 \times 2.7 \times .09 = .020$ inch units, where A is the area and d the depth of section, all in inches. And moment of inertia about the axis of the total section is $I_0 = I + Ay^2 = .020 + 2.7\ [5.65 - 4.24]^2 = .02 + 2.70 \times 1.99 = 5.39$ inch units, where A, as before, is area and y is the distance between axis, or moment of transference, all in inches.

Moment of inertia of bulb angle stiffeners about its own center of gravity is, as taken from the Carnegie handbook, 13.6 inch units, and about the new axis it would be $I_0 = I + Ay^2 = 13.6 + 3.51\ [4.24 - 3.15]^2 = 13.6 + 3.5 \times 1.19 = 17.77$ inch units. Then total moment of

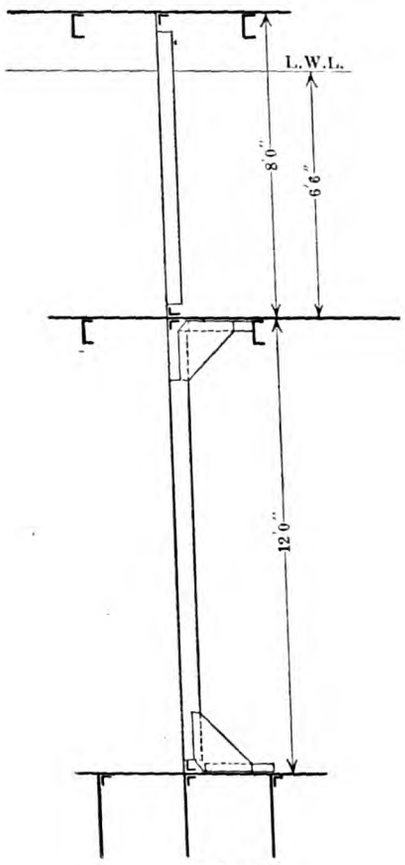

Fig. 2

inertia is $I = 17.77 + 5.39 = 23.16$ inch units, and section modulus $S = \frac{23.16}{4.24} = 5.46$ inch units.

The bending moment in this stiffener is found by the formula given before and is

$$M = \frac{Pl}{24};$$

$$P = \frac{s}{35}\left(h + \frac{l}{2}\right) l = \frac{2.25}{35}\ [6.5 + 6]\ 12 = \frac{2.25 \times 12.5 \times 12}{35} \text{ tons,}$$

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and $M = \frac{2.25 \times 12.5 \times 12}{35} \times \frac{12}{24} = 4.82$ foot tons, or

$4.82 \times 12 = 57.84$ inch tons.

Having now the bending moment, the stress in the stiffener at about mid-length, or at the end of the bracket, can be found. This is

$f = \frac{M}{S} = \frac{57.84}{5.46} = 10.59$ tons per square inch, or $10.59 \times 2{,}240 = 23{,}722$ pounds per square inch.

This stress, it is seen, is moderate and within the limits laid down in the previous article, but the true conditions cannot be arrived at before the strength of the end connections has been investigated.

If the vessel under consideration is a passenger vessel the usual practice would be to slightly increase the size of the stiffener. In this particular case it would be increased to a 6-inch by 3-inch by 12.4-pound bulb angle.

The section modulus is, in this case, figured in detail as follows:

Name	Area, Inches	Distance from Bulb of Angle, Inches	Moment, Inches
Plating	2.70	6.15	16.61
Stiffener	3.62	3.29	11.91
Total	6.32	4.51	28.52

The moment of inertia of the plate is, as before, .020 inch units, but now $I_0 = .02 + 2.70\ [6.15 - 4.51]^2 = .02 + 2.70 \times 2.69 = 7.27$ inch units.

The moment of inertia of the bulb angle, from Carnegie's handbook, is 18.6 inch units and $I_0 = 18.6 + 3.62\ [4.51 - 3.29]^2 = 18.6 + 3.62 \times 1.49 = 23.99$ inch units.

Then the total moment of inertia is $I = 23.99 + 7.27 =$ 31.26 inch units, and section modulus $S = \frac{31.26}{4.51} =$ 6.93 inch units.

The bending moment, of course, is as before, and hence the stress in the stiffener is

$f = \frac{57.84}{6.93} = 8.35$ tons per square inch $= 8.35 \times 2{,}240 =$ 18,704 pounds per square inch.

This stress is most moderate, but, as before, we must investigate the end connections before we can be sure that the stress will be held to so conservative a figure as above.

As pointed out in the previous article, the functional strip of plating is of great importance, and it is found that it reduces the stress in the stiffeners a considerable amount. For example, in the above two cases if the functional plating is omitted in the calculation the stress would be, taking section modulae of bulb angles as given in Carnegie's handbook,

$f = \frac{57.84}{4.3} = 13.45$ tons per square inch.

instead of 10.59 tons per square inch in the first case, and $f = 10.15$, instead of 8.35 tons per square inch in the second case. The above figures bring out very clearly the importance of good sound rivets between the plating and stiffeners.

The next type of bulkhead to be considered is that forming the boundary of a deep ballast or peak tank. For comparison between stresses, the same figures as shown on sketch 2 have been taken for this case also.

The stiffener required by the rules for this bulkhead would be a 7½-inch by 3-inch by 16.3-pound bulb angle, and if the spacing remains the same the plating will be increased to about .34 inch thick.

The section modulus is then found as below:

Name	Area, Inches	Distance from Bulb of Angle, Inches	Moment, Inches
Plate	8.47	7.67	64.86
Stiffener	4.80	4.08	19.58
Total	13.27	6.36	84 44

I of plate $= 1/12\ Ad^2 = 1/12 \times 8.47 \times .34 + .34 =$ .081 inch units, and $I_0 = .081 + 8.47\ [7.67 - 6.36]^2 =$ $.081 + 8.47 \times 1.72 = 15.38$ inch units.

Moment of inertia of stiffener about its own axis is, from Carnegie's handbook, 34.4 inch units, and $I_0 = 34.4 + 4.80\ [6.36 - 4.08]^2 = 34.4 + 4.80 \times 5.20 = 59.36$ inch units. Total moment of inertia is $I = 59.36 + 15.38 =$ 74.74 inch units.

The section modulus is $S = \frac{74.74}{6.36} = 11.75$ inch units, and, since the bending moment is unchanged, the stress

$f = \frac{57.84}{11.75} = 4.92$ tons per square inch $= 4.92 \times 2{,}240$ $= 11{,}021$ pounds per square inch.

This stress is very moderate, but, as before, the end connections are the vital point.

A point in connection with these deep tank stiffeners; a ballast tank is usually not carried full except when the vessel is in the light condition. This would result in a material reduction in the static head and a consequent reduction in stress in the stiffener.

Suppose in the case before us, due to the vessel being in ballast condition, that the head is only to the tank top. The bending moment then is, using same notations,

$M = \frac{1}{24} Pl.$

$P = \frac{3}{35}\left(h + \frac{l}{2}\right) l = \frac{2.25}{35}\ (o + 6)\ 12 = \frac{2.25 \times 72}{35}$

Then

$M = \frac{2.25 \times 72 \times 12}{24 \times 35} = 2.314$ foot tons $= 27.77$ inch tons.

The stress, then, in the stiffener will be

$f = \frac{27.77}{11.75} = 2.36$ tons per square inch, or 5,286 pounds per square inch.

As before, suppose the functional strip of plating is omitted. This will cause, of course, an increase in stress, which is, in the full pressure condition, from 4.92 to $\frac{57.84}{8.5}$, or 6.80, tons per square inch. As before, this is a large percentage of increase.

Before taking up the stresses in the bracket rivets, I would like to point out that, while we have designed the first two types of bulkheads for a head up to the load waterline, they will, if called upon in case of accident, have to withstand a greater pressure. When a compartment is flooded, due to collision, the vessel will sink a certain amount because of lost buoyancy. If the vessel is of a design to float with a compartment open to the sea, the maximum draft under this condition would be a little below the bulkhead deck, and hence the bulkhead adjoining this flooded compartment will be subjected to

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this increased head and must withstand it to keep the vessel afloat. In the present case, under these conditions, the bending moment will be

$$M = \frac{1}{24} Pl,$$

as before, but P is increased to

$$\frac{2.25}{35}(8 + 6)\ 12 = \frac{2.25 \times 14 \times 12}{35},$$

which makes

$$M = \frac{2.25 \times 14 \times 12 \times 12}{24 \times 35} = 5.40 \text{ foot tons, or } 64.8 \text{ inch tons.}$$

The stresses resulting from this increased moment are, for the cargo vessel bulkhead,

$$f = \frac{64.8}{5.46} = 11.87 \text{ tons per square inch,}$$

and for the passenger vessel bulkhead,

$$f = \frac{64.8}{6.93} = 9.06 \text{ tons per square inch,}$$

and for the deep tank bulkhead,

$$f = \frac{64.8}{11.75} = 5.52 \text{ tons per square inch.}$$

All the above stresses are still within the yield point of the material, so as far as they themselves are concerned the vessel would still be seaworthy.

To investigate the strength of the end connections, it is necessary to determine the bending moment at the ends

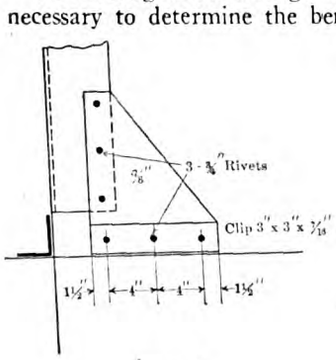

Fig. 3

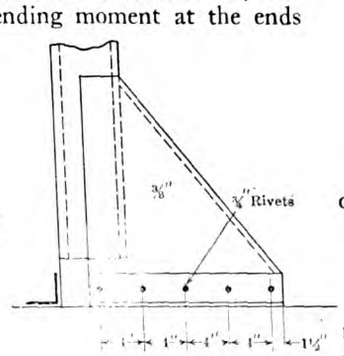

Fig. 4

and equating this to the section modulus of the riveting we can find the stress in these rivets due to the bending. With this stress, however, the shear stress due to supporting forces must be combined, giving the actual shear in the rivets making up this connection.

A fixed beam, as stated before, has its greatest bending moment at the fixed ends, and this is in this case about twice that found at the middle length above. Due to hydrostatic pressure, the end bending moment and end supporting force is greatest at the bottom, and, since it is usual practice to put the same number of rivets in the top and bottom bracket, we will here only consider the stresses in the bottom connection.

The bending moment at the bottom end of the stiffener is (using Professor Hovgaard's notation) given by the expression $M = .092\ Pl$. This includes, besides the 1/24 Pl before discussed, the additional bending moment due to hydrostatic pressure.

Since the head is taken, as before, to the load waterline, P will be as found above and give

$$M = .092 \times 12 \times \frac{2.25 \times 12.5 \times 12}{35} = 9.27 \text{ foot tons, or } 111.24 \text{ inch tons.}$$

The usual connection for the bracket of the 5½-inch bulb angle stiffener would be three ¾-inch rivets. The disposition would be about as shown in the sketch Fig. 3. The polar moment of inertia of these rivets, assuming that the holes were 13/16-inch diameter, and, consequently, also the driven rivets, would be $I_p = 2 \times 4^2 \times .519 = 16.61$ inch units, and the section modulus would be

$$s = \frac{16.61}{4} = 4.17 \text{ inch units.}$$

This would give the stress in these rivets, due to bending alone, as

$$P = \frac{M}{s} = \frac{111.24}{4.17} = 26.7 \text{ tons per square inch.}$$

This in itself is far too high and is not at all in proportion to the stress in the stiffener itself.

To find the shear due to direct load, it is first necessary to find the supporting force at the bottom. This force is given by the following equation:

$$P_b = \frac{wlhs}{2} + \frac{7}{20} wl^2 s \text{ pounds,}$$

where w = weight of water per cubic foot.
h = head in feet.
l = length of stiffener in feet.
s = spacing of stiffeners in feet.

$$P_b = \frac{64 \times 6.5 \times 12 \times 2.25}{2} + \frac{7 \times 64 \times 144 \times 2.25}{20} =$$

5,616 + 7,258 = 12,874 pounds, or 5.75 tons.

From this reaction the shear in rivets is

$$q = \frac{5.75}{3 \times .519} = 3.69 \text{ tons per square inch.}$$

These two stresses when combined give the total shear on the rivets, which is

$$f = \sqrt{q^2 + P^2} = \sqrt{3.69^2 + 26.7^2} = \sqrt{726.51} = \text{about } 26.95 \text{ tons per square inch.}$$

This is true only for the outer rivet of the bottom connection, but is the maximum stress. Since the ultimate shearing strength of mild rivet material is only 22.5 tons per square inch, it is seen that this connection is too weak, and that in this case we cannot maintain the stress found in the stiffener on the assumption that the ends are fixed, but, rather, that this stress will be largely increased.

The connection for the 6-inch bulb angle would be the same as for the 5½-inch bulb and the figures above would hold for both cases.

If it is decided to put four ¾-inch rivets in this connection, the stresses would be reduced and are found below. The rivets will still be 4 inches center to center, and hence

$$I_p = 2 \times 2^2 \times .519 + 2 \times 6^2 \times .519 = 4.15 + 37.37 = 41.42 \text{ inch units,}$$

and

$$s = \frac{41.42}{6.0} = 6.91 \text{ inch units.}$$

Then

$$P = \frac{111.24}{6.91} = 16.09 \text{ tons per square inch,}$$

and

$$q = \frac{5.75}{4 \times .519} = 2.76 \text{ tons per square inch.}$$

This gives

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$$f = \sqrt{2.76^2 + 16.09^2} = \sqrt{263.91} = \text{about } 16.25 \text{ tons per square inch.}$$

This stress is still too high and not comparable to the stress in the stiffener itself.

Five ¾-inch rivets would not be out of reason for this stiffener. This would give stresses as follows, taking the riveting as shown in the sketch (Fig. 4):

$$I_p = 2 \times 8^2 \times .519 + 2 \times 4^2 \times .519 = 66.43 + 16.61 = 83.04 \text{ inch units.}$$

$$s = \frac{83.04}{8.0} = 10.38 \text{ inch units.}$$

This gives

$$P = \frac{111.24}{10.38} = 10.72 \text{ tons per square inch,}$$

and

$$q = \frac{5.75}{5 \times .519} = 2.21 \text{ tons per square inch,}$$

which gives

$$f = \sqrt{2.21^2 + 10.72^2} = \sqrt{119.80} = \text{about } 10.93 \text{ tons per square inch.}$$

This stress is about right and compares well with the stress in the stiffeners.

For the 6-inch stiffener the five rivets as above give a satisfactory result and are not very much greater than the stress in the stiffener.

In the case of the 7½-inch bulb stiffener on the tank bulkheads the classification societies would require at least five ¾-inch rivets. If this is done the stress in the rivets will be the same as found immediately above. Five rivets for this size bulb angle is rather scant, and six would give us a stress more nearly equal to that in the stiffener. As-

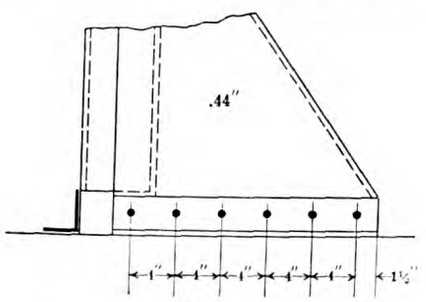

Fig. 5

suming six are fitted, the stress would work out as below, taking the rivets as indicated in the sketch (Fig. 5):

$$I_p = 2 \times 2^2 \times .519 + 2 \times 6^2 \times .519 + 2 \times 10^2 \times .519 = 4.15 + 37.37 + 103.80 = 145.32 \text{ inch units,}$$

and

$$s = \frac{145.32}{10.0} = 14.53 \text{ inch units.}$$

This gives

$$P = \frac{111.24}{14.53} = 7.67 \text{ tons per square inch,}$$

and

$$q = \frac{5.75}{6 \times .519} = 1.85 \text{ tons per square inch,}$$

Hence,

$$f = \sqrt{1.85^2 + 7.67^2} = \sqrt{62.25} \quad \text{about } 7.89 \text{ tons per square inch.}$$

This stress, while moderate, is still not nearly equal to the stress in the stiffener itself. In view of this it might in this case be allowable to increase the size of rivets to ⅞-inch in diameter. To keep the size of the bracket down, it would be permissible to retain the pitch of rivets at four inches. Assume holes punched 15/16-inch diameter. This would then be the size of the driven rivets. The moment of inertia would vary exactly as the area of the rivet, as also would the section modulus, and hence the stresses would vary inversely as the area. Following this line of reasoning the final stress in the rivets would be

$$f = 7.89 \times \frac{.519}{.690} = 5.82 \text{ tons per square inch.}$$

This stress compares very favorably with that obtained for the stiffener itself in the early part of this paper.

In conclusion, it is intended to find the stress in the rivets when the stiffeners are subjected to the maximum head—that is, when the vessel has sunk to a draft nearly level with the bulkhead deck.

The bending moment at the bottom is, in this case,

$$M = .092\ Pl,$$

and

$$P = \frac{s}{35}\left(h + \frac{l}{2}\right) l = \frac{2.25}{35}(8 + 6)\ 12 = \frac{2.25 \times 14 \times 12}{35}.$$

Hence,

$$M = \frac{2.25 \times 14 \times 12 \times .092 \times 12}{35} = 11.92 \text{ foot tons.}$$

Also, the supporting force at the bottom is found as before:

$$P_b = \frac{whls}{2} + \frac{7wl^2s}{20} \text{ pounds} = \frac{64 \times 8 \times 12 \times 2.25}{2} + \frac{7 \times 64 \times 144 \times 2.25}{20} = 6{,}912 + 7{,}258 = 14{,}170 \text{ pounds,}$$

or 6.32 tons

With these forces and the section modulus of the riveting previously found, we can obtain the stresses for the three-rivet, four-rivet, five-rivet and six-rivet connections, respectively.

For the three ¾-inch rivets,

$$P = \frac{11.92 \times 12}{4.17} = 34.06 \text{ tons per square inch.}$$

$$q = \frac{6.32}{3 \times .519} = 4.06 \text{ tons per square inch.}$$

$$f = \sqrt{4.06^2 + 34.06^2} = \sqrt{1{,}176.57} = \text{about } 34.30 \text{ tons per square inch.}$$

For the four ¾-inch rivets,

$$P = \frac{11.92 \times 12}{6.91} = 20.55 \text{ tons per square inch.}$$

$$q = \frac{6.32}{4 \times .519} = 3.04 \text{ tons per square inch.}$$

$$f = \sqrt{3.04^2 + 20.55^2} = \sqrt{431.54} = \text{about } 20.75 \text{ tons per square inch.}$$

For the five ¾-inch rivets,

$$P = \frac{11.92 \times 12}{10.38} = 13.68 \text{ tons per square inch.}$$

$$q = \frac{6.32}{5 \times .519} = 2.43 \text{ tons per square inch.}$$

$$f = \sqrt{2.43^2 + 13.68^2} = \sqrt{193.05} = \text{about } 13.88 \text{ tons per square inch.}$$

For the six ¾-inch rivets,

$$P = \frac{11.92 \times 12}{14.53} = 9.84 \text{ tons per square inch.}$$

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$$q = \frac{6.32}{6 \times .519} = 2.03 \text{ tons per square inch.}$$

$$f = \sqrt{2.03^2 + 9.84^2} = \sqrt{100.95} = \text{about } 10.04 \text{ tons per square inch.}$$

For the six 7/8-inch rivets,

$$f = 10.04 \times \frac{.519}{.690} = \text{about } 7.55 \text{ tons per square inch.}$$

In order to clarify the results of the above calculations and to make a discussion of the figures easier, they are gathered together and arranged in the form of a table, which is given below.

RECAPITULATION OF STRESSES IN BRACKETED BULKHEAD STIFFENERS

Nature of Stress	Ordinary Cargo Bulkheads: Head to Load Water Line	Ordinary Cargo Bulkheads: Head to Bulkhead Deck	Passenger Vessel Bulkheads: Head to Load Water Line	Passenger Vessel Bulkheads: Head to Bulkhead Deck	Ballast and Peak Tank Bulkheads: Head to Load Water Line	Ballast and Peak Tank Bulkheads: Head to Bulkhead Deck
Bending moment at mid-length	4.82 Ft/Tons	5 40 Ft/Tons	4.82 Ft/Tons	5.40 Ft/Tons	4.82 Ft/Tons	5 40 Ft/Tons
Stress at extreme fibre at mid-length	10.59 Ts/□"	11.87 Ts/□"	8.35 Ts/□"	9.06 Ts/□"	4.92 Ts/□"	5.52 Ts/□"
Stress at extreme fibre without plating	13.45 Ts/□"		10 15 Ts/□"			
Bending moment at bottom	9.27 Ft/Tons	11.92 Ft/Tons	9.27 Ft/Tons	11.92 Ft/Tons	9.27 Ft/Tons	11.92 Ft/Tons
Reaction at bottom	5.75 Tons	6.32 Tons	5.75 Tons	6.32 Tons	5.75 Tons	6.32 Tons
Stress in rivets due to bending—						
Three ¾-inch rivets	26 70 Ts/□"	34.06 Ts/□"	26.70 Ts/□"	34.06 Ts/□"	26.70 Ts/□"	34.06 Ts/□"
Four ¾-inch rivets	16.09 Ts/□"	16.09 Ts/□"	16.09 Ts/□"	16.09 Ts/□"	16.09 Ts/□"	16.09 Ts/□"
Five ¾-inch rivets	10.72 Ts/□"	13.68 Ts/□"	10.72 Ts/□"	13.68 Ts/□"	10.72 Ts/□"	13.68 Ts/□"
Six ¾-inch rivets	7.67 Ts/□"	9.84 Ts/□"	7.67 Ts/□"	9.84 Ts/□"	7.67 Ts/□"	9.84 Ts/□"
Six ⅞-inch rivets						
Stress in rivets due to bottom reaction—						
Three ¾-inch rivets	3.69 Ts/□"	4.06 Ts/□"	3.69 Ts/□"	4.06 Ts/□"	3.69 Ts/□"	4.06 Ts/□"
Four ¾-inch rivets	2.76 Ts/□"	3.04 Ts/□"	2.76 Ts/□"	3.04 Ts/□"	2.76 Ts/□"	3.04 Ts/□"
Five ¾-inch rivets	2.21 Ts/□"	2 43 Ts/□"	2.21 Ts/□"	2.43 Ts/□"	2.21 Ts/□"	2.43 Ts/□"
Six ¾-inch rivets	1.85 Ts/□"	2.03 Ts/□"	1.85 Ts/□"	2.03 Ts/□"	1.85 Ts/□"	2.03 Ts/□"
Six ⅞-inch rivets						
Total shear in rivets—						
Three ¾-inch rivets	26.95 Ts/□"	34.30 Ts/□"	26.95 Ts/□"	34.30 Ts/□"	26.95 Ts/□"	34.30 Ts/□"
Four ¾-inch rivets	16.65 Ts/□"	20.75 Ts/□"	16.65 Ts/□"	20.75 Ts/□"	16 65 Ts/□"	20.75 Ts/□"
Five ¾-inch rivets	10.93 Ts/□"	13.88 Ts/□"	10.93 Ts/□"	13.88 Ts/□"	10 93 Ts/□"	13.88 Ts/□"
Six ¾-inch rivets	7.89 Ts/□"	10.04 Ts/□"	7.89 Ts/□"	10.04 Ts/□"	7.89 Ts/□"	10.04 Ts/□"
Six ⅞-inch rivets	5.82 Ts/□"	7.55 Ts/□"	5.82 Ts/□"	7.55 Ts/□"	5.82 Ts/□"	7.55 Ts/□"

Ultimate strength of mild steel shapes, 28 to 33 tons per square inch.
Elastic limit of mild steel shapes, 18 to 20 tons per square inch.
Ultimate shear strength of mild steel rivets, 21 to 24 tons per square inch.

Maximum allowable stress in shapes should be $\frac{30}{2} = 15$ tons per square inch.

Maximum allowable shear in rivets should be $\frac{22.5}{2} = 11.25$ tons per square inch.

Suggested working stress in shapes, 10 tons per square inch.
Suggested working stress in rivets, 8 tons per square inch.

The figures in the table speak for themselves in showing that there has not been enough investigation into the riveting of brackets. The riveting as called for by the rules of the various classification societies appears too light.

In the former article on free-ended stiffeners greater stresses in the stiffeners themselves were found than in the above analysis, and this fact may tend to explain the high stresses found in the bracket rivets. That is, if the stresses in both types of stiffeners were taken to be the same, we would be led to the conclusion that the brackets were not intended to fix the ends of the stiffeners absolutely, but rather only partially so. This reasoning would lead to Mr. A. Murray's method of figuring stresses mentioned in the early part of this paper. It appears to the author that if this is the case it is the wrong method of design and should be abandoned, and instead an attempt should be made actually to fix the ends of the stiffeners or otherwise consider them free-ended. Any halfway design involves dangers of failure because the true stresses cannot be obtained by mathematics. In any case, to fix the ends means only the addition of one or two rivets with bracket over that required by the registration societies, and the gains involved justify this.

Another point to be considered is the question of induced stresses. Often bulkhead bracket clips are connected to comparatively weak or non-rigid parts of the hull structure. Any deflection, of course, in the member to which the brackets are secured means the loss of all the fixing power of the brackets. In all but the smallest bulkheads this point must be watched and local reinforcements or doubling may be desired at the deck and tank top. It should be borne in mind that giving of the bracket usually means failure of the bulkhead, since the size of stiffener associated with brackets is not large enough to stand up after the support of a bracket has been removed due to local deflection or some such other cause.

A point which should be made at this time is that practically it will be next to impossible to absolutely fix and hold the ends of the stiffeners. This is due to the nature of the construction. A riveted connection will most always slip when subjected to a stress of any magnitude, and the instant that this stretch occurs the stiffener is no longer fixed. While the stress in the connection is still reasonable, the stiffener will act as a partially fixed beam, but no method can be given for determining the percentage of fixation and the resulting stress in the stiffener cannot be figured, although, of course, it is known that it will be between the limits of the fixed and free-ended conditions. If the stress is large, for example, as found above for the condition of three riveted bracket connections, the slip or stretch in the connection will be sufficiently great to destroy entirely the end-fixing properties of the brackets, and the stiffeners will then act as freely supported beams and, of course, fail. These conditions should be understood and guarded against.

The above discussion will show that it is impossible actually to predict the stresses in the rivets and brackets and also why it is important to provide ample riveting and strength in the brackets. Where it is possible to fit rigid brackets, the stiffeners should be designed as being free-ended. If desired, light brackets may be installed and the stresses in this case may be increased about 15 to 20 percent in the stiffener in consideration of the part end-fixing brackets, but in no case must the permissible stress exceed the yield point of the material.

In conclusion, it is hoped that the above figures and those contained in the former article will lead to more careful bulkhead design. When a bulkhead is put into a vessel to keep her afloat, we should know with certainty that it will perform its function. A weak bulkhead, like any other structure which is too weak, is just so much material and labor thrown away, and this local weakness may, by failing at a critical time, cause the loss of considerable more material and labor, to say nothing of the lives involved.

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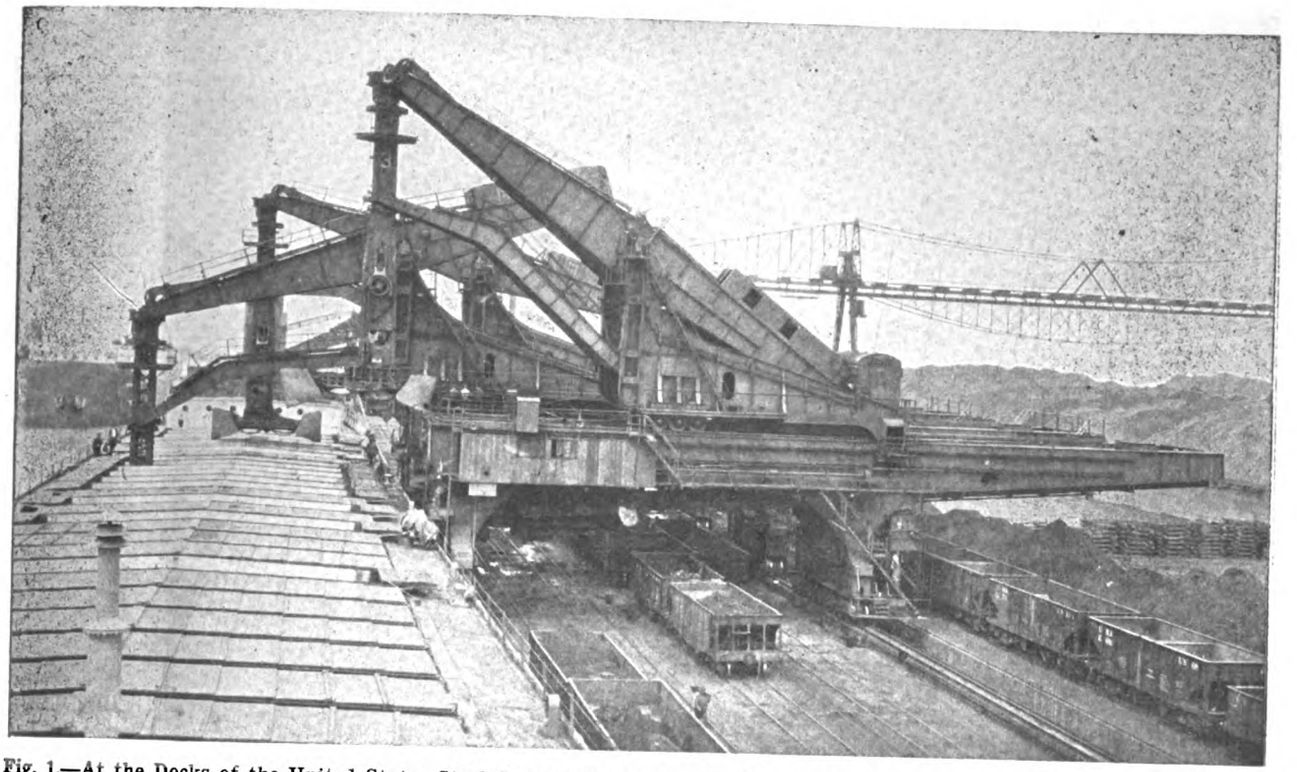

Fig. 1.—At the Docks of the United States Steel Corporation, Conneaut, Ohio, Seven Unloaders Are in Operation. Four Are Shown in the Illustration.

Automatic Ore Unloaders on the Great Lakes

Two Operators Control Unloading, Weighing and Delivery of Ore from Ship's Hold to Car or Storage Pile

THE equipment provided for handling ore shipments on the Great Lakes is representative of the highly specialized facilities which can be developed to reduce handling costs. Units of seven and eight of these automatic ore unloaders are installed at Ashtabula and Conneaut. At the latter port, 76,000 tons of ore are unloaded by 15-ton buckets in twenty-four hours.

The unloader consists of a main framework mounted on trucks which travel along runway rails, as shown in the accompanying illustrations. This framework extends back to the rear runway over a temporary storage pile where the ore can be discharged if desired. Underneath the space between the front and rear runways, railroad tracks are built where ore-carrying cars can be placed under the machines and loaded with ore for transportation to the furnace plants. The girders of the main framework form a support for auxiliary runway rails, on which a trolley travels. The trolley supports a balanced walking beam, from the outer end of which a stiff bucket leg depends. The attached bucket is operated by machinery located in the enclosed house on the walking beam—horizontal movements by means of moving the trolley backwards and forwards on the girders, and vertical movements by the operation of the walking beam. The forward portion of the beam being out of balance, the bucket descends by gravity as soon as the brakes of the hoisting mechanism are released.

The bucket shells are each made of a single piece of plate formed to the shape illustrated. These bucket shells are usually provided with manganese steel-cutting lips to resist the abrasive action of the ore. Fig. 4 shows the bucket in operation in the hold of a modern ore carrier after most of the ore has been removed and the balance has been scraped into position so that it can be handled by the bucket.

A receiving hopper located at the forward end of the main framework, between the main girders, is provided for the purpose of receiving the ore discharged from the bucket. The capacity of this hopper is about three full bucket loads. The hopper serves as a balancing point for the ore between the bucket and the cars or storage, as the case may be. The bottom of the hopper is provided with outlet gates through which the con-

> On the Great Lakes American freighters manned by high-wage crews carry ore, grain and coal one thousand miles for fifty cents (2/1) a ton, and make a profit. Where an ocean vessel may operate all the year round, the lake freighter has a season of only eight months. No ocean rate in the world is so low as that for carrying a ton of ore from Duluth to Conneaut, Ohio. Secretary Redfield says that it would make a Norwegian tramp steamer go out of business in despair. This feat in transportation is achieved through labor-saving devices for loading and unloading lake freighters.

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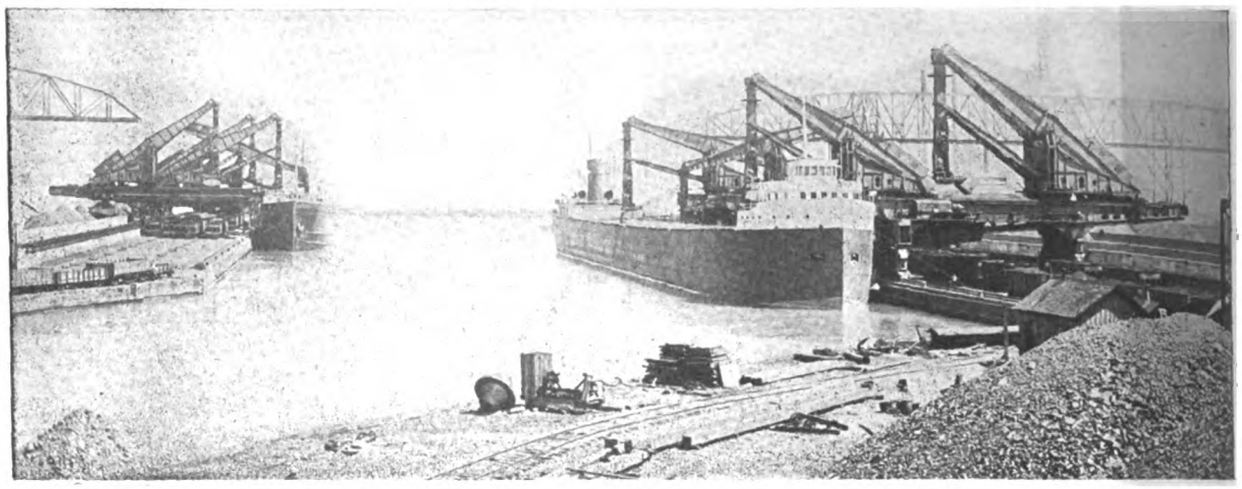

Fig. 2.—On the Docks at Ashtabula Are Installed Eight Electrically-Operated Unloaders, Each Having a 15-Ton Bucket. The Unloading Capacity of These Dock is 76,000 Tons in Twenty-four Hours

tents is discharged as required into a larry which runs on an auxiliary track suspended from the under side of the main girders.

Unloading machines of this type have been made in two sizes, the smaller size having a capacity of ten tons and the larger size, shown in the installations illustrated, having a capacity of from fifteen to seventeen tons in the bucket shells. The machine shown is electrically operated throughout. Its speeds are regulated so as to operate through a complete cycle in about 50 seconds.

Eight Machines Unload 70,000 Tons in 22 Hours

In Ashtabula eight machines of this type having a capacity of fifteen tons each unloaded seven boats having a total capacity of 70,000 tons in 22 hours' actual time. At other points four machines working in boats having capacities up to 13,000 tons have unloaded these cargoes in about three hours and twenty-five minutes.

Records compiled by the Wellman-Seaver Morgan Company, Cleveland, Ohio, makers of the apparatus, extending over long periods show unloading costs ranging from 2½ to 4½ (0/1¼ to 0/2¼) per ton, which includes superintendence, labor, repairs and materials on the machines, as well as the cost of power and light.

Operation of the Equipment

After the boat has been placed alongside of the dock the bucket is lowered through one of the hatches into the ore. After filling, the walking beam hoist mechanism lifts the bucket out of the vessel. The auxiliary trolley is then moved backward until the bucket is brought directly over the main hopper between the girders. Here its contents is discharged into the hopper and the bucket returned to the boat for another load. The ore in the main hopper is discharged into the larry, which has been brought to a point directly underneath the discharge gates.

After receiving its load from the main hopper, the larry is moved to a point where its contents can be discharged either into the cars standing on the railroad track beneath the main span of the girders or into a temporary storage pile under the cantilever at the rear of the machines. The ore so placed in this temporary stock pile cannot be reclaimed by means of these machines. Their function is solely one of unloading the cargo from the ships. The

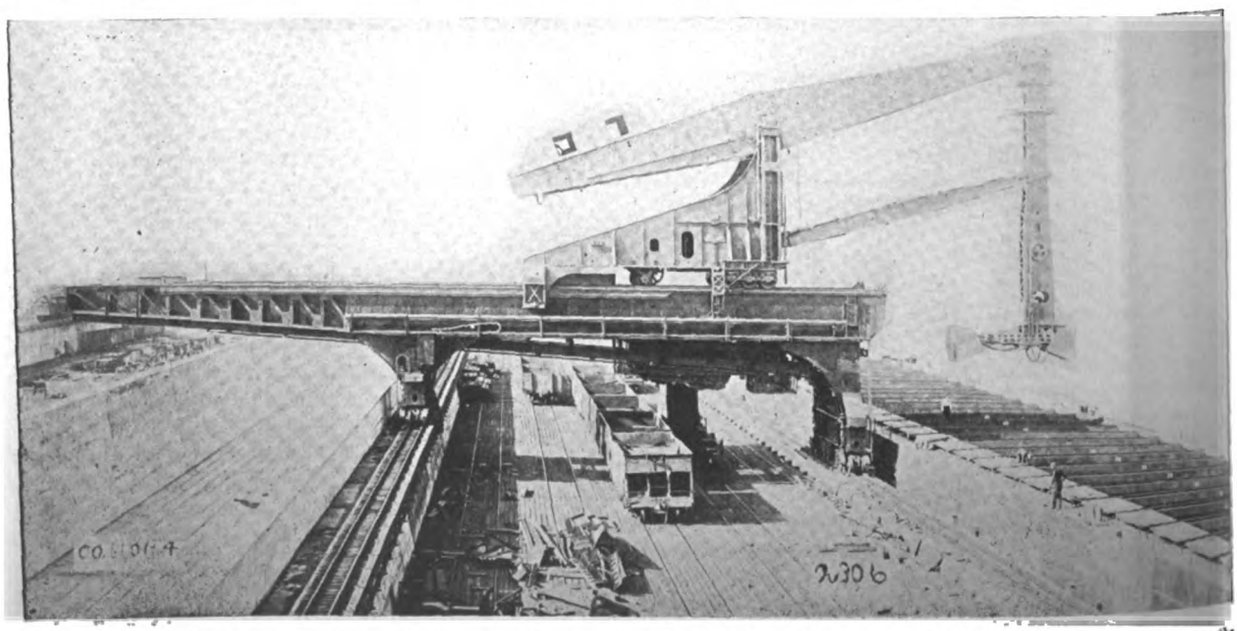

Fig. 3.—View of the Automatic Unloader Showing the Complete Mechanism. Over Fifty of These Machines Are in Use on the Great Lakes Unloading Ore Steamers

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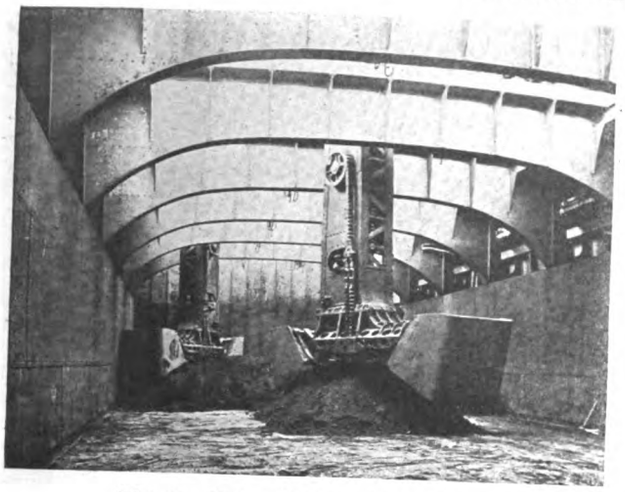

Fig. 4.—Filling Buckets in Ship's Hold

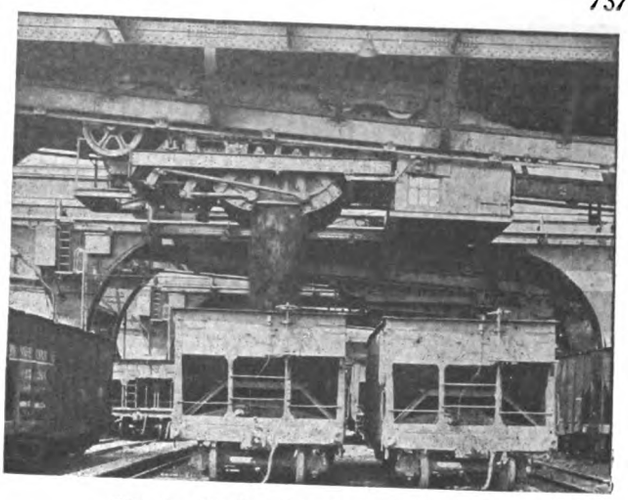

Fig. 5.—Discharging the Ore Into Cars

larry hopper is provided with scales so that the contents is accurately weighed and recorded. In this way a car can be loaded to its allowable capacity and an accurate record kept of the amount of ore so discharged, thus eliminating the necessity for the use of track scales.

Two operators are required for the operation of one of these machines. One, whose station is in the bucket leg directly over the bucket shell, controls all of the motions of raising and lowering the bucket, of traveling the trolley back and forth, and moving the machine along the dock from one hatch to another. The second operator, stationed in a cab on the larry, controls the movement of the larry, the operation of the larry gates, and the weighing of the ore.

In addition to the vertical movement of the bucket, a motion of rotation around its vertical axis is accomplished by a rotating mechanism, located adjacent to the bucket-closing mechanism. This motion is introduced for the purpose of turning the bucket at right angles to the hatchway, in order to secure as great a reach lengthwise of the boat as possible, permitting the bucket to reach out under the hatches and remove ore which is not directly beneath the hatch opening. The distance from point to point of the bucket shells when open is approximately 21 feet.

The scale larry into which the main hopper discharges, has a capacity of between 35 and 45 tons. Two larry loads are intended to constitute a full carload of ore. The position of the discharge gates of the larry is shown in Fig. 5. These are so arranged that all or a portion of the contents of the larry may be discharged. Scales record accurately the amount of ore released. The larry track is inclined; the larry is pulled up the incline by means of ropes and descends by gravity.

Electrical Control

Usually these machines are electrically operated throughout. In some cases, however, machines of the same general type have been made to operate by steam and hydraulic cylinders, water being supplied to the operating cylinders by means of a steam accumulator, which furnishes water at a pressure of 1,000 pounds per square inch. The electrically operated machines are usually designed for a 220-volt direct current. Alternating current is never used. The motors required for the equipment of one of these machines are as follows:

	Number of Motors	Horsepower
Beam hoist	1	275
Bucket closing	1	120
Bucket rotating	1	25
Trolley travel	1	120
Hopper gates	1	100
Longitudinal travel	1	100
Larry travel	1	150
Larry gates	1	40

The control equipment for these motors is of the magnet switch type throughout, having master controllers in the operators' cabs in the bucket leg and on the larry.

Electric current is supplied to these machines by means of insulated conductor rails running the length of the main runways. The current is collected from these rails by means of pick-up shoes and distributed to the various portions of the machine. A similar controlling device is employed for supplying the main current to the trolley. Conductor rails are attached to the main framework of the machine and the current collected from these rails by means of pick-up shoes attached to the trolley.

8,000-Ton or "B" Type Steamship Building at Hog Island Shipyard

AT the Hog Island yard the American International Shipbuilding Corporation is building to the order of the United States Shipping Board Emergency Fleet Corporation two types of vessels, known as the "A" type and "B" type. The "A" type is a single-screw two-deck cargo vessel with a deadweight carrying capacity of 7,500 tons, designed for a speed of 11 knots. Plans of the "A" type ship, showing the general arrangement and scantlings were published in our February issue. The "B" type ship is of 8,000 tons deadweight capacity, but arranged for service as a troop ship and fitted with propelling machinery of 6,000 shaft horsepower, designed to give the vessel a sea speed of 15 knots. The main particulars of the "B" ship are as follows:

Length overall	448 feet
Length between perpendiculars	435 feet
Beam, molded	58 feet
Depth to shelter deck	40 feet
Height between shelter and upper decks	9 feet 6 inches
Height between upper and main decks	10 feet 6 inches
Block coefficient on length between perpendiculars	0.650
Load draft	28 feet
Load displacement	12,900 tons
Shaft horsepower	6,000
Speed	15 knots
Number of passengers (troops)	1,200
Approximate weight of steel hull	3,200 tons
Approximate weight, wood and outfit	800 tons
Approximate weight, machinery	800 tons
Approximate weight, light ship	4,800 tons
Total deadweight on 28-foot draft	8,000 tons
Load displacement	12,900 tons

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As in the case of the "A" ship, the "B" type ship is designed without sheer or deck camber. There is no rise of floor and the bilge is turned at a radius of 3 feet 6 inches. The vessel is a single-screw shelter-deck steamer with bridge, forecastle and poop built with a straight stem and cruiser form of stern and fitted with a single mast and eight derrick posts. The parallel middle body extends for a distance of about 15 percent the length of the ship amidship.

The hull is divided by ten watertight steel bulkheads, extending up to the shelter deck, forming seven cargo holds and the engine and boiler spaces. This subdivision of the hull insures that the vessel will float with two compartments flooded at a draft of 28 feet with 60 percent permeability for the cargo spaces and 80 percent permeability for the engine and boiler spaces.

Cargo Holds

The holds and 'tween-deck space are used for cargo except when carrying troops, which are berthed in the upper 'tween decks. The space in the forecastle head is for wet cargo stores, carpenter shop and wash room for the troops; the space in the poop is used for the steering gear, stores and wash room for the troops. In the bridge accommodations are provided for the galley, cold storage stores, etc. At the foreward end of the upper 'tween-deck space forward of the chain locker is used for the stores.

The peaks can be used for ballast or as salt water trimming tanks, while provision is also made for carrying fresh water in these tanks. The entire double bottom, except under the engine space, is arranged for carrying oil fuel. The center keelson is watertight throughout. The double bottom tank under the engine space is subdivided into two tanks for boiler feed by a watertight center division. Wing deep tanks for fuel oil are also fitted, extending up to the second deck.

Hull Construction

As shown by the drawings, the hull is built with transverse framing. Above the tank top the frames are channels spaced 27 inches center to center. In the peaks the frames are angles spaced 24 inches apart; in the inner bottom the frames are angles on both the open and solid floors. The reverse frames throughout are angle bars.

The center keelson is continuous and has a depth of 48 inches. Two longitudinals are fitted on each side of the center keelson, continuous between solid floors. Web frames are fitted in the engine space and also in the 'tween decks over watertight bulkheads and also forward as panting frames. Side stringers are fitted forward in the holds and in the 'tween decks only as required for panting strength at the ends.

The upper and shelter deck beams are channels fitted on every frame. The ten watertight bulkheads which extend to the shelter deck are stiffened vertically, while the forward collision bulkhead is stiffened both vertically and horizontally. Only a single row of pillars is fitted in the holds, but strength is provided by three rows of deck girders, the wing rows being worked clear of the hatch coamings.

Deck Machinery

There are seven main cargo hatches through the second, upper and shelter decks, and a small hatch in the bridge deck which may be used in case coal is burned in the boilers. The hatches are served by fourteen 5-ton booms, two booms being fitted at each hatch. Each cargo boom is handled by a double-cylinder, single-drum, single-geared, reversible steam winch, 8¼ inches by 10 inches.

The deck machinery includes a steam windlass with 10-inch by 10-inch cylinders fitted with two wildcats and two large winch heads for warping the ship; a right- and left-hand screw type steam steering gear with 9-inch cylinders; a capstan with 8-inch by 8-inch engine installed on the poop; two 10-kilowatt electric generators for lighting the ship, and two 4-ton direct-expansion ammonia ice machines. The vessel is heated by steam.

Boilers

Steam is supplied at 200 pounds pressure by six Babcock & Wilcox oil-fired watertube boilers. The boilers are placed athwartships and have a total heating surface of 17,400 square feet. They are fitted with Foster superheaters, which give a superheat of 75 degrees Fahrenheit and are operated under forced draft. The products of combustion are led to a single stack, which has an area of about 94 square feet and extends to a height of 76 feet above the keel.

The oil fuel, which is burned in a mechanical atomizing system, is pumped from the double bottom to a settling tank by a horizontal duplex pump, 9 inches and 7 inches by 12 inches, and then forced to the burner by two horizontal duplex 6-inch and 4-inch by 6-inch pumps.

Main Engines

The main propelling machinery consists of Curtis turbines of 6,000 shaft horsepower, which drive the propeller at a normal speed of 100 revolutions per minute through a 40 to 1 double-helical, double-reduction set of gearing. An astern turbine is incorporated in the ahead casing, designed to develop two-thirds of the full speed ahead torque on not more than two-thirds of full speed revolutions of the shaft.

The propeller is a solid four-bladed wheel 18 feet in diameter.

Engine Room Auxiliaries

The engine room auxiliaries include a main condenser with about 8,500 square feet cooling surface, a centrifugal double-suction circulating pump with 20-inch suction and discharge and a capacity of 10,000 gallons per minute against a head of 15 feet driven by a single-cylinder reciprocating engine 10 inches diameter by 12 inches stroke; a wet and dry twin-beam air pump, and the following service pumps:

Two vertical simplex main or auxiliary feed, 14 inches and 9 inches by 24 inches.

One horizontal duplex ballast, 10 inches and 12 inches by 12 inches.

One horizontal duplex fire, bilge and general service, 12 inches and 8½ inches by 12 inches.

One horizontal duplex sanitary, 6 inches and 5¾ inches by 6 inches.

One horizontal duplex engine room bilge, 6 inches and 5¾ inches by 6 inches.

One horizontal duplex fresh water, 6 inches and 5 inches by 6 inches.

Two horizontal duplex evaporator feed 4½ inches and 3¾ inches by 4 inches.

One horizontal simplex combined air and circulating, 10 inches and 12 inches and 12 inches by 12 inches.

One horizontal duplex oil transfer, 9 inches and 7 inches by 12 inches.

Two horizontal duplex lubricating oil, 7½ inches and 6 inches by 10 inches.

Two horizontal duplex oil service, 6 inches and 4 inches by 8 inches.

One horizontal duplex ice machine circulating, 6 inches and 5¾ inches by 6 inches.

The auxiliary equipment also includes a feed water heater, feed and filter tank of 1,200 gallons capacity, two evaporators with a capacity of 20 tons each per twenty-four hours, and an auxiliary condenser of 800 square feet cooling surface.

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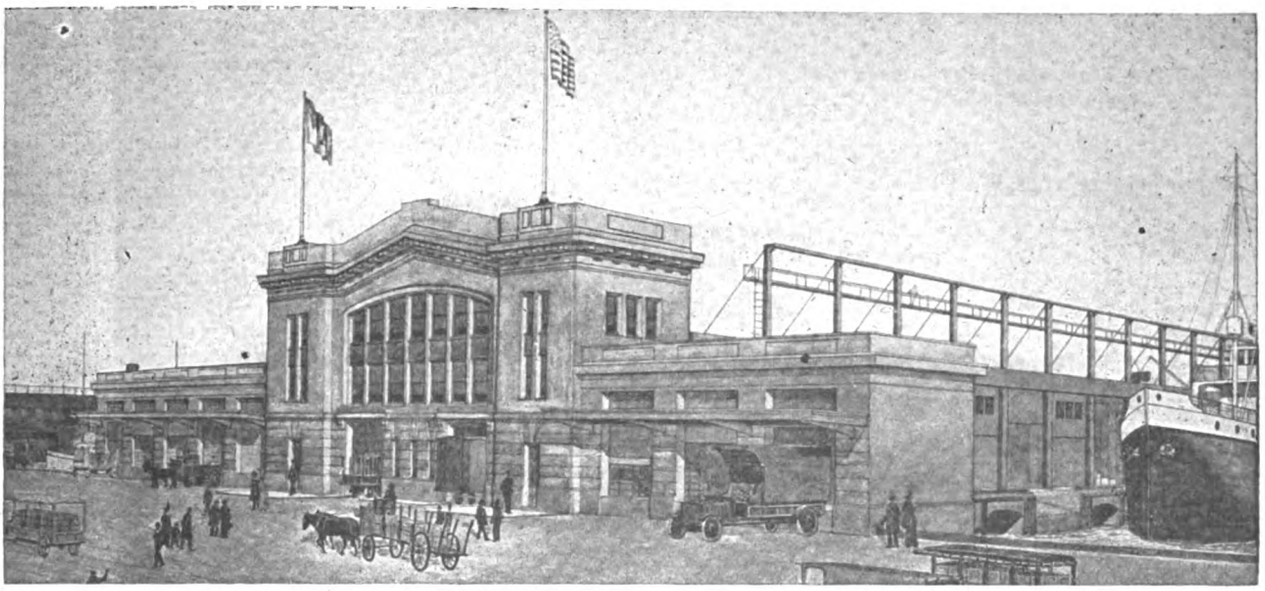

Fig. 1.—Proposed Commercial Pier No. 9 North. Department of Wharves, Docks and Ferries, City of Philadelphia

Port Improvements at Philadelphia

Comprehensive Developments Planned—Construction Begun on Three Piers Costing Over $3,000,000—Two New Piers in Service

ALTHOUGH little has been said regarding the new harbor developments at Philadelphia, the city officials are silently forging ahead in an effort to provide the most advantageous shipping facilities possible.

On December 1, 1918, the city completed the construction of Pier No. 78, South Delaware wharves, the first of the Moyamensing piers. These consist of two groups, the upper group comprising four piers 900 feet long by 250 feet wide, and two piers 900 feet long by 300 feet wide, with a 300-foot waterway between the piers; the lower group consists of four piers, each 1,200 feet long by 300 feet wide, with a water span between the piers of the same width. The Philadelphia quartermaster terminal is situated between the groups.

The pier head of Pier No. 78 is shown in Fig. 2. As may be noted, it is of the double-deck type, with office buildings and three-deck bulkhead sheds at its inshore end. On the outside of the building depressed car tracks

* Data supplied by George S. Webster, Director, Department of Wharves, Docks and Ferries, Philadelphia, Pa.

Fig. 2.—Inshore Elevation of Municipal Pier No. 78

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have been built, and a wagonway has been constructed through the center of the pier. The cost of the project has been approximately $1,814,000 (£372,000).

Details of Kenilworth Pier

On February 17 of this year a contract was awarded for the construction of Pier No. 30 South to the F. W. Marks Construction Company, Finance Building, Philadelphia, Pa. This pier, located at the foot of Kenilworth street, will be of a double-deck permanent structure, 540 feet long by 120 feet wide; it will be used for ocean steamship traffic.

The substructure will be of the timber, pile and concrete cross wall type, decked with a reinforced concrete beam and slab construction, designed for a live load of 600 pounds per square foot. The pier will be paved with asphalt blocks except at the railroad tracks, where vitrified blocks will be used. The superstructure will be a one-story steel and concrete shed, 110 feet wide by about 520 feet long, with architectural concrete elevations on the Delaware avenue and river ends.

Flanking each side of the pier at the inshore end will be constructed one-story steel and concrete bulkhead sheds. These will be 32 feet wide by 64 feet long. The pier will be equipped with two surface railroad tracks connecting with the Belt Line Railroad, and cargo masts will be installed along the full length of the dock sides of the pier. The estimated cost of the construction is $950,000 (£195,000). The company's bid was $908,420 (£186,000).

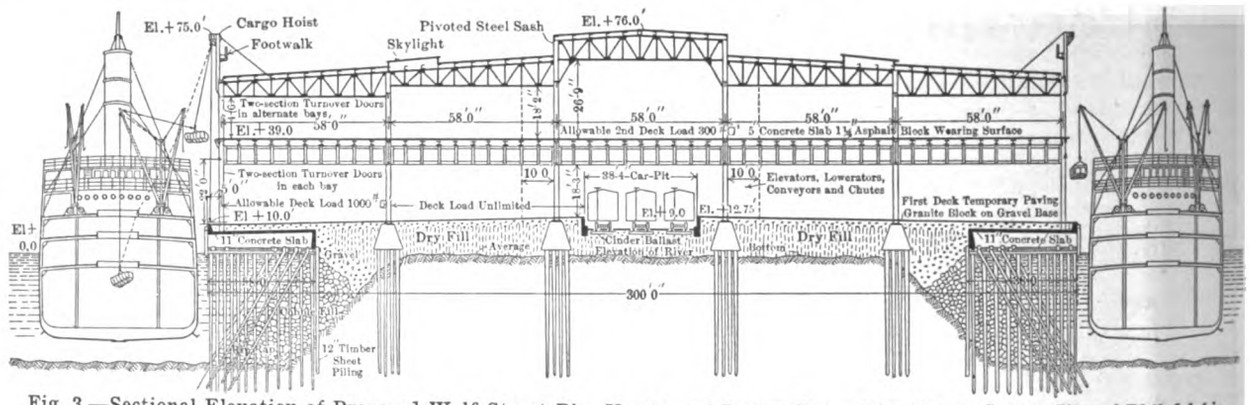

Fig. 3.—Sectional Elevation of Proposed Wolf Street Pier No. 82 and Porter Street Pier No. 84 South, City of Philadelphia. Department of Wharves, Docks and Ferries

Two 900-Foot Piers

In March a contract was let to the Arthur McMullen Company, 149 Broadway, New York, for the building of Piers Nos. 82 and 84 South. These piers will be 300 feet in width by 900 feet in length. The contract at the present time is for the substructure only, which will be of solid fill type. As may be noted from the illustration, the solid earth fill will be retained by a pile, timber and concrete construction of the cross wall type; this will be about 38 feet in width, forming the sides and outshore end of the pier, the fast land of the inshore end constituting the closing side. Bulkheads of the same type will connect the two piers and extend to the north and south of them approximately 200 feet. The company's bids estimated the work at $2,266,400 (£465,000).

Pier for River Steamers

About June 1, Pier No. 9, North Wharves, which is 100 feet wide by 535 feet long, was completed. This pier, which is intended primarily for the use of river steamers, has a deck level track connecting with the Belt Line Railroad, and is equipped with six wharf drops or adjustable ship gangways. The deck is of reinforced concrete beam and slab construction, paved with asphalt except where vitrified brick are used around the railroad tracks. The pier is capable of supporting a superimposed load of 600 pounds per square foot. The superstructure is 90 feet wide by 520 feet long, fire-proof throughout, with architectural concrete elevations on the Delaware avenue and river ends. The estimated cost of the work is $450,000 (£92,200).

The above description covers piers actually under construction. Other improvements, however, have been planned by the Department of Wharves, Docks and Ferries, which, when completed, will further increase the harbor facilities.

Future Construction Plans

The Penn Treaty pier, which it is proposed to build as an extension to the present open recreation pier, will provide a lower deck for the accommodation of freight and passenger river steamers, and an upper deck for recreation purposes. Permanent structure will be used for the new pier, the substructure being of concrete on timber piles, cut off at the low water level, and the superstructure of structural steel and concrete. The lower deck, which will be 70 feet wide by 300 feet long, will accommodate a live load of 400 pounds per square foot. This dock will be paved with asphalt, and enclosed on the dock sides with sliding doors 20 feet wide by 15 feet high. The estimated cost of the entire construction is $355,000 (£73,000).

New Pier at Foot of Allegheny Avenue

Plans and specifications are also being prepared for the construction of a double-deck pier, to be built on the property now owned by the city at the foot of Allegheny avenue. This pier, to be known as Pier No. 127, North Wharves, will be provided with two surface railroad tracks, one on each side of the pier outside of the shed connecting with the Philadelphia Belt Line Railroad, and will be equipped with cargo masts along the entire length of the dock sides of the pier. The superstructure will be a two-story steel and concrete shed, 106 feet wide by approximately 610 feet long. One million dollars (£205,000) is given as the estimated cost of the construction.

Besides these piers, to be used for commercial purposes only, it is planned to build a new recreation and steamboat pier for the use of small pleasure craft, to cost about $100,000 (£20,500). Comly street recreation pier will also be enlarged, at an estimated cost of $10,000 (£2,050).

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The Marine Terminal Railway

General Principles Governing Location and Arrangement of Tracks and Movement of Freight

BY H. MC L. HARDING*

THE terminal railway comprises the railway tracks within the limits of the terminal area and is to be considered as under separate terminal rules or principles rather than in accordance with the usual railway practice. For example, it is desired by railway engineers to have the radii of the track curves as great as possible and not less than about 358 feet radius, while terminal engineers, within the terminal, desire to have these curves as small as commercially practicable, and in general have the lower limit about 150 feet radius. Freight cars can readily be drawn around a 150-foot radius curve without extra connecting links.

Radius of Curves

The reason for the smaller radii is to avoid reserving too much valuable waterfront space for the track curves. The area for a 358-foot radius or 716-foot diameter would be difficult to secure at most marine terminals. Where, however, the terminal railway lead leaves the trunk line or siding, then the curve and frog should be what the railway company may desire.

By the terminal engineers adhering to and insisting upon the application of terminal principles within the terminal grounds, as are established or may be established by the Society of Terminal Engineers, long, futile arguments will be avoided.

At a public terminal on the quays where all kinds of freight are transferred there should be two or three railway tracks for outbound freight located between the edge of the quay wall and the shed.

Location of Railway Tracks

If the front of the shed be located 35 to 40 feet from the edge of the quay, then for two tracks the center of the track nearest the shed may be about 28 feet from the edge of the quay and the center of the second track about 15 feet from the edge of the quay. Where the width is 35 feet and there is a full arch crane spanning the outside track, these relative dimensions are modified.

These tracks should be parallel to the quay wall and the top of the rails flush with the pavement, the same as car tracks in paved streets traversed by vehicles, so that the track space can be readily traversed by drays.

Where there are to be three tracks along the quay frontage, there should be about fifty feet between the front of the shed and the edge of the quay. In this case the center of the track nearest the shed may be 43 feet from the edge, the center of the second track 30 feet distant, and the center of the third 17 feet.

The above distances are subject to modifications, but may serve as a general rule. It is desired to have sufficient space between the cars on the tracks nearest the quay edge for the travel of drays. Much freight in the future will be drayed to and from terminals within a radius of 30 miles by large motor trucks.

If there should be no buildings—that is, an open quay—the above spacings may be observed. The above pertains to public terminals where all kinds of materials are to be transferred and handled, and not to an iron ore or coal terminal.

With two tracks there should be cross-overs from one track to the other about every 100 feet. These cross-overs can be so arranged that at one time one track can be the switching track and at another time the loading track. Where there are three tracks, the center track is generally the switching track and the other two tracks the unloading or the loading tracks.

The front quay-wall tracks are usually termed coordinating tracks and are largely used for outbound freight—that is, from car to vessel; but if no vessel be present, then from car to shed. At Baltimore, according to the report of the Port and Harbor Facilities Commission of the United States Shipping Board, more of the outbound freight is transferred directly. These tracks can also be used for inbound freight, although most inbound freight must first be transferred into the shed for assorting and distributing. The tracks to the rear of the shed are chiefly for freight from the shed to the interior. These rear tracks should be connected at convenient locations with the front tracks.

Track Approaches

As in many cases, where the quay wall is projected into the stream, then to reach the front portion of the quay the railway track approaches are on trestles, which, as the adjoining units of the quay are constructed, are usually filled in.

The location of the tracks at the rear of the shed will vary, depending upon the design of the shed whether the doors are continuous in every bay or in every other bay and whether the warehouse is located within about sixty feet to the rear of the shed and parallel to it.

Co-ordination of Terminal Elements

To secure a succession of rapid mechanical freight movements, all the elements of the terminal must be coordinated and work in unison. The most rapid loading of railway cars has no advantage unless the necessary number of empty cars are placed in position for loading and unless the cars already loaded are taken away. Similarly, in the unloading of cars, the empties must be at once removed and then the place filled by full cars.

The quick movements of these cars depend upon the terminal track layout. The spacing of two tracks at the Continental ports varies from 14 feet 9 inches to 16 feet 5 inches, differing a little from American practice. The method of operation is generally that, when the cars on one line of tracks are being loaded, the switching engine brings in a train of empty cars on the second track and takes the full trains away, and then the same method of procedure is carried on, only on the other tracks; therefore each line of tracks is successively used as a switching track nearly the same as with American practice.

Two-Track Operation

A continual succession of these car movements will only be possible if all the cars are loaded within the same time and a corresponding number of cars stand ready for loading or discharging at each crane.

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At a terminal for miscellaneous freight this is seldom possible. As a rule, one or another of the tracks must be used for a switching track. The rails cannot, therefore, be occupied completely by cars. They must be kept open at the switching points. As a rule the operation should be so regulated that first the rails must be cleared of the loaded cars and then the empty cars drawn up.

Three-Track Operation

With three tracks these difficulties disappear, but too often there is not space for the three tracks. It may be said that there should be cross-overs on each side of the space served by one crane, so that as soon as cars in this space are loaded or emptied they can be removed. With a sufficient number of tracks, the placing and the removing of cars can take place without interfering in the least degree with the work on the quay.

If sufficient quay space in width can be secured, large sums can be saved in rail extensions. In some cases, where there is not much fluctuation in water levels, as along canals, and there is a sloping bank, one leg of the quay crane can be placed on a low wall a little above the water level, so that space can more easily be acquired for the additional third quay rail track.

At a railway terminal, where there is to be speed and successful operation, the rail track approaches to the different terminal locations should usually be at least double and ample for the inbound and outbound car movements.

Depressed Tracks

The rails of the tracks are sometimes depressed so that the floor of the car is even with a platform at the rear of shed. If, however, there are continuous doors with dray service only, not cars, then the platforms are not so essential. Canopies over the platforms interfere with overhead transferring machinery.

One great disadvantage of the depressed track is that it is difficult to transfer freight between the shed and warehouse by motor trucks or other trucks on the surface. Transferring cranes of various types can easily perform this service or it can be done by conveyors above the depressed tracks and cars, without interfering with the moving trains.

Freight Movements Between Shed and Warehouse

There are disadvantages in having two-story sheds with a few overhead platforms from shed to warehouse, as there is much travel both in the shed and warehouse to reach these cross-over passageways. A warehouse generally has six or more stories, all of which must be served. A crane with a jib able to travel the whole length of the shed and warehouse and connect the two at any point gives much greater flexibility of service than having only the few overhead platforms within the length of each marine berth of six hundred feet or more. The crane can transfer from the shed to any of the stories of the warehouse by any direct movement.

Waterfront property is so much more valuable than the land a few hundred feet to the rear that warehouses where freight may remain for months should be located on the rear lands with correctly planned railway tracks and drayways.

In most instances a 60-pound or 85-pound rail will suffice for terminal tracks. The ties, however, should be spaced closer than is the usual practice, and the ties should also be longer. This is especially advantageous for the tracks in front of the shed so as to distribute any excessive loads of the locomotives and cars over as large an area as possible.

Tracks can be extended into and through the lower story of the warehouse, but never within the shed.

The spacing of the tracks in the lower story of the warehouse will depend upon the design of the terminal warehouse, but there should also be an easy mechanical transference between the cars and the upper stories within the warehouse, chiefly by elevators.

Placement and Storage Tracks

The tracks, the location of which has already been described, may be called the movement service tracks. There should be other tracks near the quay or pier for placing full cars for immediate shipment and empty cars for receiving incoming cargoes. At a greater distance from the quay, and from the sheds and warehouses should be extensive storage, classification and other terminal tracks.

The placement and storage tracks may conform to the standard types of ladder tracks. As a rough guide to the length of storage tracks necessary, and only to indicate a method for estimating this trackage, the following may be of service:

Length of Trackage Necessary

The quay for ocean-going ships may be considered as composed of units, each unit with a berthing frontage of 600 feet.

If there are four steamships, each unloading 5,000 tons of cargo for through freight, there would be required to contain the 20,000 tons of cargo from 1,500 to 2,000 cars, if all is through freight. As one part may be for local delivery and another for transshipment, and still another for the warehouse, it might be safe to consider that there should be provision for 1,000 cars to receive this freight.

A low average for the through freight from a ship is 50 percent.

Besides these empty cars there may be an average of 500 full cars waiting to be unloaded into ships, warehouses and sheds.

One thousand five hundred cars, allowing 40 feet for each car, would require a trackage of about 60,000 feet, or from ten to twelve miles.

The above figures are given only to show the necessity for providing ample space for storage and other tracks and not as any absolute rule.

It often happens that the trunk line railway or railways have extensive storage tracks near a terminal, and, as the railway will greatly profit by this through traffic, these storage tracks can be utilized to advantage for the terminal.

On piers there should be railway tracks on each side within a space of thirty-five feet in width, with cross-overs between the two tracks.

In many cases it will be found to assist in rapid transference of the freight, if the terminal railway tracks are first located and then the terminal buildings. Placing the warehouses diagonal to the waterfront, where there are piers, has greatly facilitated the track layout.

Conclusions

First.—The terminal railway tracks should, in the layout, conform to terminal engineering principles.

Second.—There should be direct co-ordination between ship and rail, and the loading and unloading should go on continually, planned so as to avoid possible congestion.

Third.—Mechanical appliances should be installed for transference and handling to secure speed, and outbound freight, when possible, should be transferred direct from car to vessel.

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Designing Marine Machinery for Economy

Features of Machinery Design That Affect Fuel Consumption of the Ship—Reduction and Simplification of Piping—Furnace and Condenser Losses

BY COMMANDER H. C. DINGER, U. S. N.

MOST marine machinery is designed to run and to be reliable, to weigh as little as practicable and to cost as low as possible; but few ships and machinery are designed on the basis of economy of fuel consumption. Of course, this is considered. Nowadays the water rate of the engine is looked into; some consideration is given to securing a good vacuum, and even superheat is investigated. But economy of fuel as a constant ideal in the minute details of design is usually treated as an unnecessary and pestiferous refinement.

The designer often studies the question of weight; but does he remember that economy of fuel is the greatest possible saver in weight, and one that is always on the job? Does the designer always consider that the lead of piping or the design of the cut-out valve affects fuel economy? Perhaps some do occasionally, but as a general rule the piping is led to get there and any valve that is available is used.

An object lesson in designing for economy is indicated in the performance of groups of the United States 35-knot destroyers. In the vessels built by one yard the oil per knot is materially less than that of vessels turned out by several other builders. Now, this big difference, particularly at the high powers, was not obtained by magic, nor at an increased cost of manufacture, nor by the use of superior material. The better-designed vessels are the cheapest on the actual cost basis. It was produced by designing the ship and all the details in her with a special consideration for fuel economy. The result—they cost less, weigh less, use less fuel, have higher speed, and are more durable.

Now, the ideas that secured this marked result on these destroyers can be made use of in designing any marine installation. They are not mysterious, hidden, or intangible. They are just as simple as two and two make four. It is necessary always to keep in mind the principle of conservation of energy, that the force of gravity exists, and that heat and mechanical energy are mutually convertible, that friction is a loss whether it is in a bearing or in a water pipe.

Here are some of the matters often neglected, or not fully considered.

The loss due to friction in piping systems.

The steam economy due to simplified piping.

The direct routing of steam and water through the piping systems.

Permit the forces of nature to help rather than work against them.

Friction in Piping

This can be decreased in the following ways:

1. Reduce the amount of piping.
2. Place the parts to be connected as close to each other as possible.
3. Do not reverse directions of flow, if possible to avoid it.

Here are some instances where friction is unnecessarily increased: (1) Return flow condensers and feed heaters; (2) the placing of condenser tubes athwartships. The reversal of flow means greater resistance to the pump and the need for more surface. The movement of the ship naturally causes any medium to go from forward aft in line with the keel; yet how much water on board ship is unnecessarily moved from side to side or even from aft forward?

Sharp corners and abrupt angles in water and steam piping mean increased resistance and loss in friction. Easy bends and the fairing up of angles help to design for economy.

The loss due to friction in pipes applies to water, oil and air pipes as well as to steam pipes. The sum total is, of course, not over a few percent of the total power. However, a very large part of it is an unnecessary loss, and therefore one that should not be permitted in good design. "Many a mickle makes a muckle," and when we are designing for economy no half of one percent or hundredth of one percent should be lost, if a little more care in design will save it.

Uptake Temperature

This is almost a stranger to many who are building and operating ships; but whether of high or low degree, most designers and operators scarcely take the trouble to inquire except to assume it exists at some figure. The temperature of the feed water entering the boilers is rarely ever much more than 200 degrees. If we are designing for efficiency, our uptake temperature should not be so very much greater than this; certainly not over 300 degrees F., thus allowing 100 degrees F. temperature difference—really an ample margin. This ought to be a pretty fair allowance for any heat transfer apparatus that has any reasonable claims for efficiency. Our condensers and feed heaters get down to a temperature difference of about 5 degrees F. to 10 degrees F. by using the counterflow principle. Why not take a hint and allow our boilers the same privilege? It can be done. Will not someone try it?

Condenser Losses

It may be a little startling to say so, but there is less load on a condenser when you have the highest vacuum than when you have a poor one. Most marine condensers have considerably more surface than is necessary to condense the steam, and yet do not produce a particularly good vacuum. Surface does not produce the vacuum; it condenses the steam. The vacuum depends more on the air tightness of the condensing system and the efficiency of the air pump, and, of course, no air pump can overcome a very bad air leak. In designing for economy, therefore, see that you actually have plenty of circulating water, and that your condensing system is airtight—not nearly airtight or reasonably airtight, but *actually* airtight. Do this by avoiding joints and connections, and where a joint has to be, don't hide it. Avoid all possible occasions for air leaks.

Any condenser will condense the steam fairly well if it is given plenty of water, but many marine condensers seem to be designed with the misguided intention of holding on to the water, instead of letting it slide through the condenser just as fast and as easily as possible. There is plenty of water in the ocean, so why not use it? We have return flow and even triple pass marine condensers, and the resistance to the flow of water on some of these

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is something not to be sneezed at. All this resistance adds to the fuel bill.

Since the vessel moves through the water, a scoop is the most natural, simple and inexpensive way to get the circulating water to the condenser. But how few of the total marine installations use this! Of course we need water when backing or maneuvering, but a small circulating pump on a by-pass and the main injection will supply that. A single-pass scoop condenser has greater capacity and efficiency than any other marine type, and you can dispense with the large circulating pump which, of course, is never large enough in the tropics. The scoop, however, increases its capacity with increased speed and has no bearings to get hot.

BALANCE

Does this affect the coal pile? The connection is a bit roundabout, but it certainly does affect fuel consumption. Unbalance is like a leak in a pipe; it allows energy that should be spent in driving the vessel to amuse itself tearing things to pieces. Do we look at it in this light or is it only when it gets so bad that things won't hold together that we deign to seek the acquaintance of two supposedly mysterious elements—*static* and *dynamic* balance? It is well to have them with you in motors, shafting and propellers. They are not very difficult to secure. They come almost naturally with good workmanship. If we balance our shafting and our propellers carefully, we not only prevent the ill effects of vibration, but we then build for economy. Furthermore, by carefully balancing we are likely to discover hidden flaws and irregularities that otherwise would not come to light.

Vibration is the visual manifestation of unbalance. When all moving parts are properly balanced, vibration is very much reduced. The machinery, of course, will operate even with considerable vibration, but the presence of vibration means loss in fuel, if it does not mean anything more serious.

TEMPERATURE DIFFERENCE

Marine machinery has incorporated in it much heat transfer apparatus, namely: Boilers, condensers, feed heaters, oil heaters, oil coolers, evaporators, etc., etc. Now the capacity of any heat transfer surface is a function of the temperature difference. In designing for economy this must always be before one, and no good chance to increase the temperature difference is to be neglected. A larger temperature difference permits greater capacity per unit surface and hence saves weight and space. A proper consideration of temperature difference makes it possible to save for a useful purpose a great deal of what may otherwise be waste heat. This applies particularly to boilers (where all possible heat in furnace gases should be extracted) and to condensers (where as little heat as possible should be taken away by the circulating water).

AIR

Air is desirable in its place to breathe and to support combustion, but in nearly all other parts of marine machinery it is the enemy of efficiency. Air is really more pestiferous than salt water because it gets into so many more places where it is not wanted. Here are a few:

(1) Air in the water side of boilers causes corrosion.

(2) Air, particularly warm air, in copper piping causes corrosion.

(3) Air collecting on either side of the surface in condensers, evaporators, distillers or feed heaters renders the cooling or heating surface inefficient, besides causing corrosion.

(4) Air in oil lines on forced lubrication causes improper flow of oil and interferes with the drainage of the oil.

It is therefore plain to see that one of the guiding lights in designing marine machinery should read, "Design to keep air out," and then, "Design to take it out when it does get in." Air can have access in so many ways that all these ways must be considered and avoided if the designer wants the best economy.

INCLINATION OF SHAFTS

The shafts transmit the driving power, and this tends to drive the ship parallel with the axis of the waterline. If the shafts are not parallel to this, there is loss of power. It is therefore important that the inclination of shafts be as small as the structural limitations will permit.

FAIRING UP OF UNDERWATER BODY

If one believes the surface of a vessel is smooth, let him but examine one in dry dock. All manner of obstructions will be found. Rivets are not flush or smooth; sea openings have reinforcing rings that are direct obstructions, with no attempt at bevelling or stream lining; shaft hubs and struts are not made of stream line section, and the strut arms are often very close to the propellers, so close that they disturb the water going to the propellers and cause a certain amount of cavitation; bilge keels and rolling keels are often attached so that they offer much resistance; the plating in many cases has cavities, indentations and rough places that are not smoothed up or filled in.

The need of docking a vessel to remove barnacles is appreciated, but the equal need of starting out with a smooth metal surface seems sometimes to be lost sight of.

The best of our marine power installations expend about one hundred heat units to do the equivalent of twenty-five units' work. There are the following conversions: (1) Combustion in the furnace; (2) furnace heat into the heat of steam; (3) steam heat into mechanical energy in the rotating shaft; (4) the energy in the shaft into propulsive energy to drive the vessel. There are losses all the way along from the beginning of (1) to the end of (4). They may be represented approximately as follows:

100. Heat units in the coal.
80. Boiler efficiency, 80 percent.
72. Ten percent of steam for auxiliaries.
69. Less losses in piping and radiation, 2 percent.
48. Turbine efficiency, 70 percent.
46. Losses in gearing and shafting, 5 percent.
30. Propeller efficiency, 65-70 percent.
26. Excess hull resistance due to rough hull and appendages and inclination of shafts, 12 percent.

This represents a plant with a tight system of piping. Steam and water leakage, poor vacuum, etc., in whatever extent present, add still further to the losses.

Of the above sources of loss, the following are the ones that at present appear most likely to be remedied by better design and workmanship:

BOILER EFFICIENCY

There are no insurmountable reasons why a boiler efficiency of 90 percent should not be secured in ordinary practice. By laboratory methods, about 95 percent can be secured.

EXCESS HULL RESISTANCE

The proper stream lining and smoothing up of all hull obstructions and appendages can in most vessels reduce the required driving power 5 percent or more. The higher the speed, the more important this matter is.

PROPELLERS

Well-designed propellers may easily make a difference of 5 percent over the ordinary ones supplied.

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Oiling System and Bearing Designs

Success of System Described Depends Upon Workmanship and Attention Paid to Fitting Same—Old Practices Should be Stopped

BY ENGINEER-LIEUTENANT A. E. WINDRAM

BY A few rough sketches, the writer indicates how it is easy to make the majority of existing main bearings, crank pins, bearings and crosshead bearing brasses, oil-tight, on nearly any reciprocating engine, or, in fact, any bearing that requires good, careful oiling, by means of drilling crank webs into oil rings or grooves turned round the center of the journal, and corresponding oil rings or grooves in the center of the brasses connected with pipes from brasses to brasses, which are made oil-tight by sealing rings on the ends of the brasses.

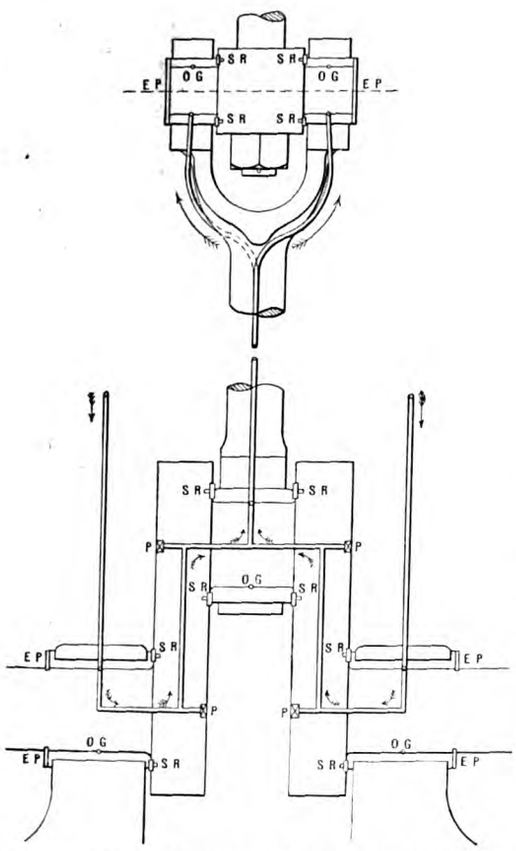

Fig. 1.—General Outline of System and Bearings That Will Retain Oil by Means of Sealing Rings and End Plates

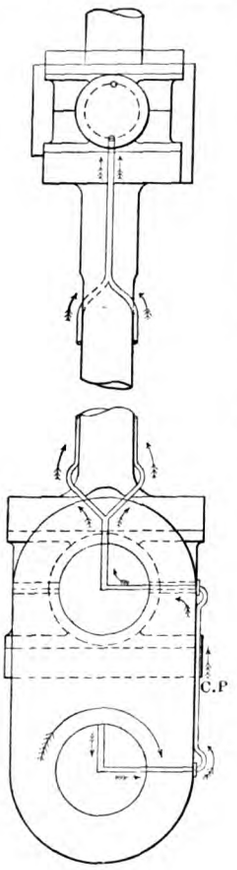

Fig. 2

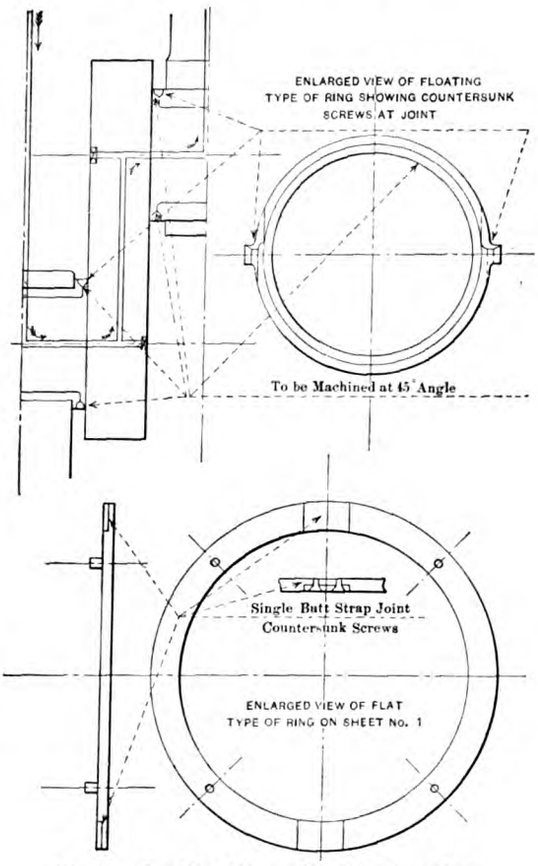
ENLARGED VIEW OF FLOATING TYPE OF RING SHOWING COUNTERSUNK SCREWS AT JOINT
To be Machined at 45° Angle
Single Butt Strap Joint
Countersunk Screws
ENLARGED VIEW OF FLAT TYPE OF RING ON SHEET No. 1

Fig. 3.—Another View of a Floating Type of Ring

Fig. 1 shows the general outline of an oiling system and bearings that will retain the oil by means of sealing rings (*SR*) and end plates (*EP*). The bearing journals have oil grooves (*OG*) turned in the center of the journals, as indicated by small circles, a half-circle groove in the journal and a corresponding half-circle groove in the bearing. The main bearing and crank bearing journals are drilled from the oil grooves to the center of the shaft, and the shaft is drilled longitudinally to meet a vertical hole in the journals; the center holes in the shaft have the ends plugged (*P*).

On Fig. 2 the crank webs are shown drilled horizontally from the edge of the web to the center. The main bearing oil hole is put into connection with the crank pin oil hole by means of a connecting pipe (*CP*), which is bolted to the outside of the crank web, as the process of drilling through the crank web from the crank pin down to the main journal oil hole is more difficult. The large arrow of rotation from left to right shows the pipe (*CP*) as leading the crank when running, so that any centrifugal effect will cause the oil to flow towards the crank journal.

The sealing rings (*SR*), as shown in Fig. 1, are let into grooves turned in the sides of the crank webs; also, holes are drilled in the center of the grooves to receive the pegs at the backs of the sealing rings, so that the rings cannot turn round with the brasses, but act as scrapers. Light springs on the pegs at the back force the rings on to the sides of the brasses. A slight recess is turned on the sides of the brasses for the rings to run in, thus making a good running joint and stopping all leakage of oil.

A larger view of a sealing ring, termed a flat type of ring, is shown in Fig. 3. The ring is built up in halves with two flush joints, and with four pegs to keep the ring in position. Fig. 3 also shows another view of a floating type of ring, with a V-section, sitting in a groove, one

* Paper read before the Institute of Marine Engineers, London.

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side running on the journal and the other on the brass. This ring is built in halves, can be fitted and adjusted, but is free to float round either with the journal or brasses and keep oil-tight.

Referring again to Fig. 1, it will be noticed that the main bearings have an end plate (*EP*) fitted that sits in a small groove or recess in the shaft, and is bolted on to the end of the brass, thus sealing up the oil and stopping any leakage along the shaft. If found necessary, a ring could be fixed to the shaft just touching and jointing with the fixed ring on the end of the brass; in fact, there are innumerable ways of sealing up the ends of the main bearing brasses. The crosshead brasses have end plates bolted on, thus sealing up the bearing round the pin.

In Fig. 1 the oil enters the pipes leading through the main bearing cups into the oil groove circle round the shaft. The oil is free to travel all around the bearing by suitable channels in the brasses; at the same time it passes into the hole drilled to the center of the shaft, and along longitudinally to the crank webs, and then at right angles from the center to the outside of the crank webs (Fig. 2). The oil next travels through the pipe (*CP*) to the center of the crank pin shaft, then at right angles along to the center of the crank journal and up to the oil groove circle turned round the center of the pin and brasses, so that the whole of the "bottom end" brasses are floating round the crank journal in oil supplied through suitable channels in the brasses. The foot of the connecting rod (Fig. 2) is drilled in the form of a *Y*, because two pipes are required to run up the connecting rod so that the oil can be conveyed through the crank pin brasses up through the foot of the connecting rod and out into the two pipes up the crosshead brasses. The two pipes are fitted round the fork end of the connecting rod and up through the bottom brass into the oil groove circle turned round the crosshead journal pins; thus the crosshead brasses are kept floating in oil.

The pipes leading into the main bearings (Fig. 1) can be led to oil reservoirs placed above the cylinder covers, so that if gravity fed, the oil is bound to go up the pipes and up the connecting rods to lubricate the crosshead bearings, or the pipes leading into the main bearings can be connected to small hand pumps, so that the oil can be pumped through the system. Not more than 5 or 8 pounds per square inch pressure would ever be required to reach any crosshead bearing.

The success of this system of oil-tight and oil-retaining bearings will depend upon the workmanship and attention paid to fitting same.

The old method of putting tins into bearings so that "you can just hear her knock," and filing away the sides of the brasses so that the only touching place is the crown of the brass, are practices that should be stopped. Well machined brasses and journals should be fitted together with a fine working fit; otherwise, if the journals are to continue to flap about inside the brasses, no oil will ever remain in the bearings. A true pin and a true brass will run when quite finely adjusted, providing the oil is sure of getting to the rubbing surfaces, and the oiling system proposed, with proper workmanship, appears to the writer well adapted for the purpose designed and sure to give satisfactory results in actual practice.

Observations on Side Launchings

Arrangement of Blocking—Progressive Loss of Support as Vessel Goes Down the Ways—Lifting and Tipping Pressures

BY JOHN A. MC ALEER*

THE advantages of building a ship on a level keel with the subsequent idea of a side launching are too well known to require comment. It has been, and is now, the universal practice on the Great Lakes and has lately been adopted in some yards on the coast. Articles on this subject have appeared at somewhat protracted intervals. Most of these, however, have over-emphasized the simplicity of any calculations, as well as the uniformity of hull support. In this short article it is proposed to focus the attention of interested persons on the necessity of making some calculations, simple though they may be, before launching in this manner.

It might be well to remember that all the phases of an end launching are present in a side launching, though occurring more rapidly. With a large ship an end launching may require a minute; but if this same hull had been put in sidewise, the whole operation would have been over in about one-tenth of that time. Events are therefore transpiring ten times as rapidly. Nevertheless, the critical condition of lifting or tipping may be present, and very frequently for a period sufficient to set up and damage the vessel's bottom.

Fig. 1 shows a cross-sectional view of a vessel ready for such a launching. There are generally five rows of fore and aft blocking, a center row under the keel and two outboard lines on either side. This represents what must be considered general good practice. The construction of these rows of blocking is practically identical so far as bearing surface is concerned and otherwise, except that in the outboard blocks on the water side more stability is often secured by cross ties or by increasing the base areas. They are also carried as far forward or aft as the fineness of the buttock lines will permit, but this consideration results in there being a smaller number of blocks in these outboard rows and a consequent decrease in bearing surface in this region.

The ways are timbers, generally of oak, 18 inches by 24 inches or thereabouts, placed at equal intervals along the launching berth. The spacing of these varies in different yards, but it is from ten to fourteen feet. The usual practice is to place them at regular and equal intervals, but whether this is a practice that could be bettered will be considered later.

A vessel blocked up in this manner preparatory to launching will be well supported at all points, and the pressure between ways and butter boards will not be too large.

Take, for example, a full canal-sized, lake-built ship 261 feet by 43 feet by 28 feet, with an estimated launching weight of about 1,300 tons, supported on 19 ways and 5 rows of blocking, affording 19 keel blocks, 13 or 14 blocks in each No. 1 row, and perhaps 8 or 9 in each bilge row, or about 60 blocks for a total. This will give about 22 tons per block, and, assuming 6 square feet of bearing surface per block, a pressure of about 3½ tons per square

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foot. This is a very moderate pressure, but let us see whether this is a fair way of analyzing the launching conditions.

As the vessel slides down the ways there is a rapid and progressive loss of support as each line of blocking passes beyond the way ends, and, consequently, a sudden increase and localization of bearing pressures. Before the vessel is finally floated, all the support afforded by the ways must be given by one line of blocking. This must, of course, be one of the inshore rows. If the strains are of a lifting character they will finally fall on the No. 2 row, but if of a tipping character, on the No. 1 line.

To determine this point, the calculations must be similar to those of an end launching. It will depend on the relation of the buoyant moments about these two block lines to the weight moments about the same points. To have a lifting condition means excess of buoyant lifting moment, and, generally speaking, this requires ways running under the surface of the water or rapidly increasing camber at the way ends. This also would furnish the safest conditions to launch under. The land pressures will finally be given by the inshore No. 2 course of blocks and will equal the ship's weight less the buoyancy. The other extreme would be a case where the way ends are so high above the water surface that the hull, while sliding down the ways, throwing the different lines of blocking in succession and increasing the pressures, overbalances after losing the support of the keel blocking and tips on the No. 1 course as an axis, before acquiring any buoyant support. In such a launching there will be an appreciable time during which the entire weight of the hull rests on a single line of blocks, with a very possible damage to the bottom of the vessel.

Let us again revert to our ship and determine pressures. There will be about 13 blocks in this No. 1 row, of 6 square feet each, or 78 square feet, sustaining a weight of 1,300 tons. This will mean an increase in the pressures to about 16⅔ tons per square foot.

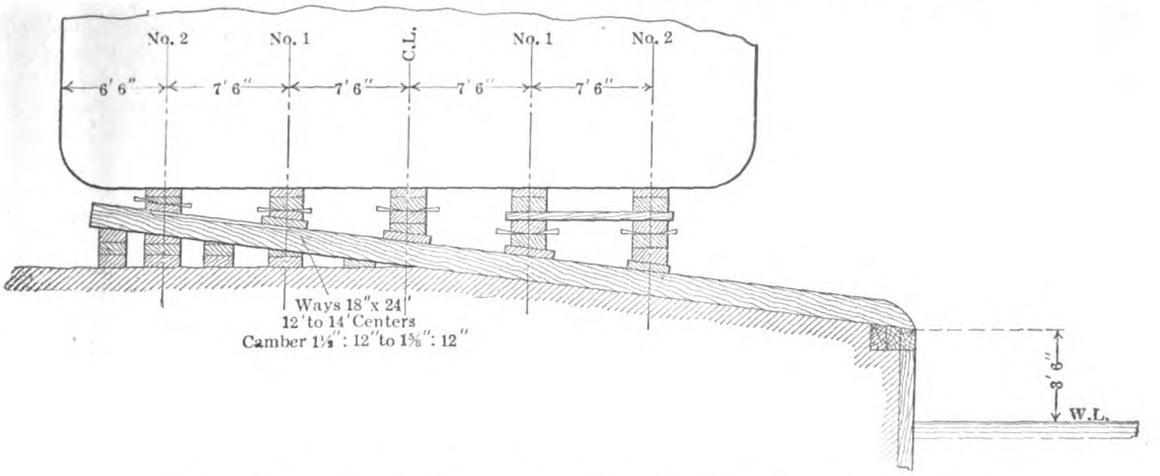

Fig. 1.—Diagram Showing Cross Section of Vessel and Ways Ready for Launching

Between these extreme cases can occur a number of intermediate ones under different conditions of water level, camber, etc. For instance, we can assume that the vessel has already acquired a substantial buoyant moment when she throws the keel blocks and acquires a tipping moment. Any buoyancy obtained before tipping will decrease the total pressure on ways and the pressure per square foot as well. Damage to the bottom need only be expected in cases of large tipping pressures, and its position can be safely predicted to be in that strake of plating under the No. 1 blocks.

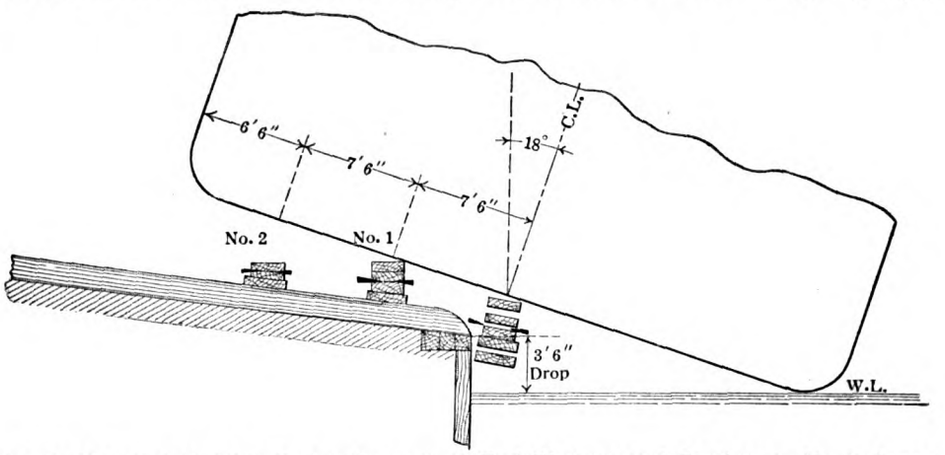

Fig. 2.—Vessel Just After Losing Support of Keel Blocking and Tipping on No. 1 Course

So far the pressures have been calculated on the supposition that the entire bearing surface of the No. 1 blocks remains in contact with the bottom throughout the tipping period. This, of course, is not the case. These blocks will act precisely as the fore poppets of an end launching where no provision, such as soft packing, is made for the large and rapid change of angle. There will be an intense localization of pressure at the outboard edge of these blocks, and the buckles in the bottom shell will be deeper at these points.

Attention was directed earlier to the decrease in the

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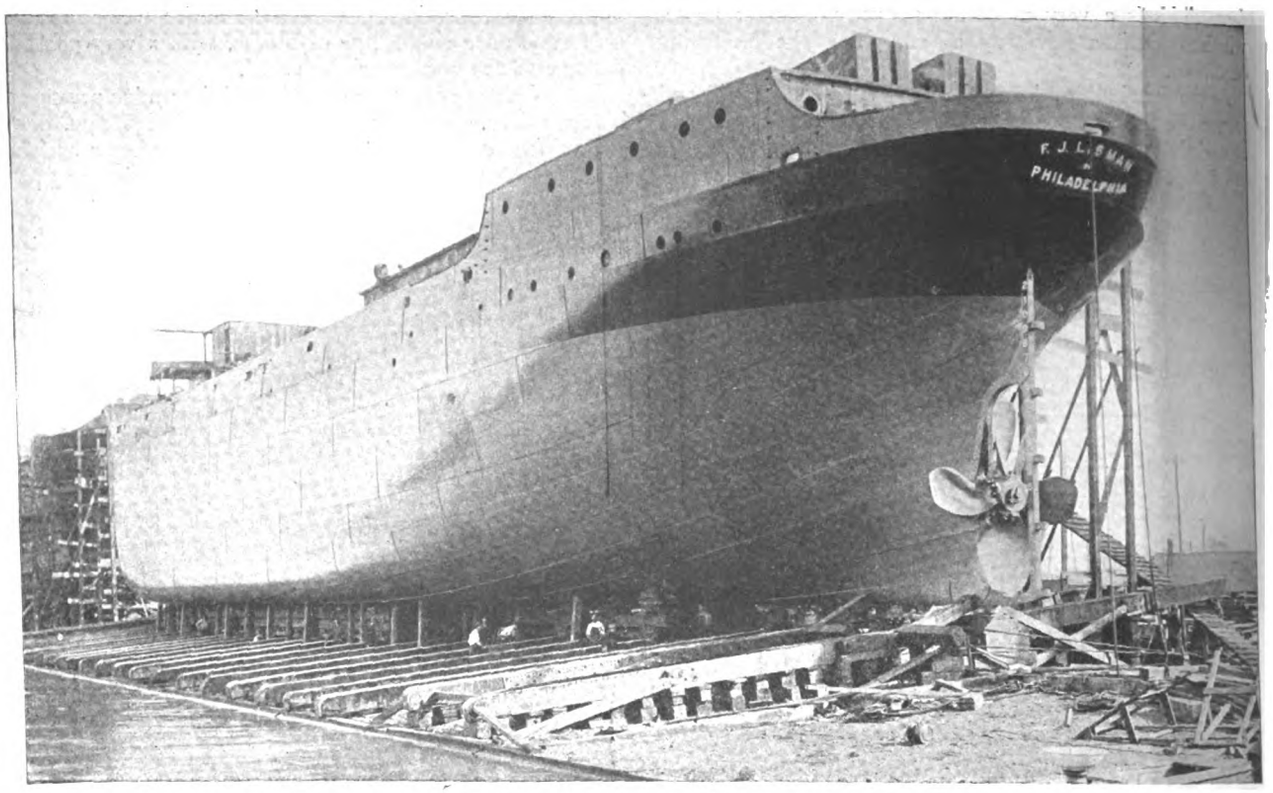
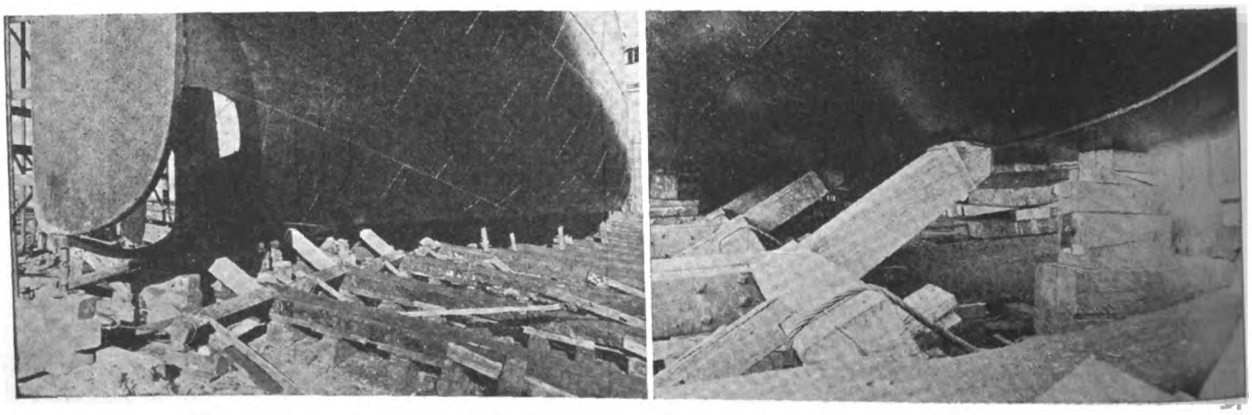


Fig. 3.—Lake Vessel Ready for Side Launching

number of blocks as one went overboard, due to buttock limitations. Under the ship in question there would be about 13 blocks in the important No. 1 course. With the ways on 12-foot centers, this means that the hull is supported for a distance of 150 feet, with an overhanging length of 50 feet at both ends. At the critical moment, the hull would resemble a uniformly loaded beam, uniformly supported for a portion of its length, with overhanging ends. Under these conditions, the hull as a girder being somewhat flexible, there will be a further and severe localization of support at the terminal blocks of the critical row; and when damage occurs it will be found much more severe at these points.

Special care should be taken in launching fine lined ships where extreme cases of tipping are to be expected. And in all cases of tipping it would be well to make provisions for large pressures at these places. One remedy would be a closer spacing of the ways at these points, with a provision for crushing strips at these terminal blocks certainly, and perhaps at all the blocks of the critical row.

Concerning safe pressures, one is naturally reluctant to predict. Where there has been no provision for localization of these, damage has always resulted where the pressures figured statically are 16 tons or over. Whether or not this would occur if special provision were made in the form of crushing strips or in a closer spacing of the ways under the terminal blocks, it would also be unwise to prophesy, but it is believed they could then be safely carried as high as 12 tons per square foot.



Figs. 4 and 5.—Launching Triggers and Dagg ers at Stern and Bow for Releasing the Vessel

While Fig. 1 shows the usual custom of five rows of blocking, some yards have added another row on the inshore side. This extra row will be immaterial in the case of a lifting launch, but cannot be recommended when tipping is to be expected, for the following reasons:

Let the rows be numbered 1, 2 and 3 from keel to bilge. As soon as the keel blocks have passed over the way ends, the hull tips on the No. 1 row, rises clear of the other

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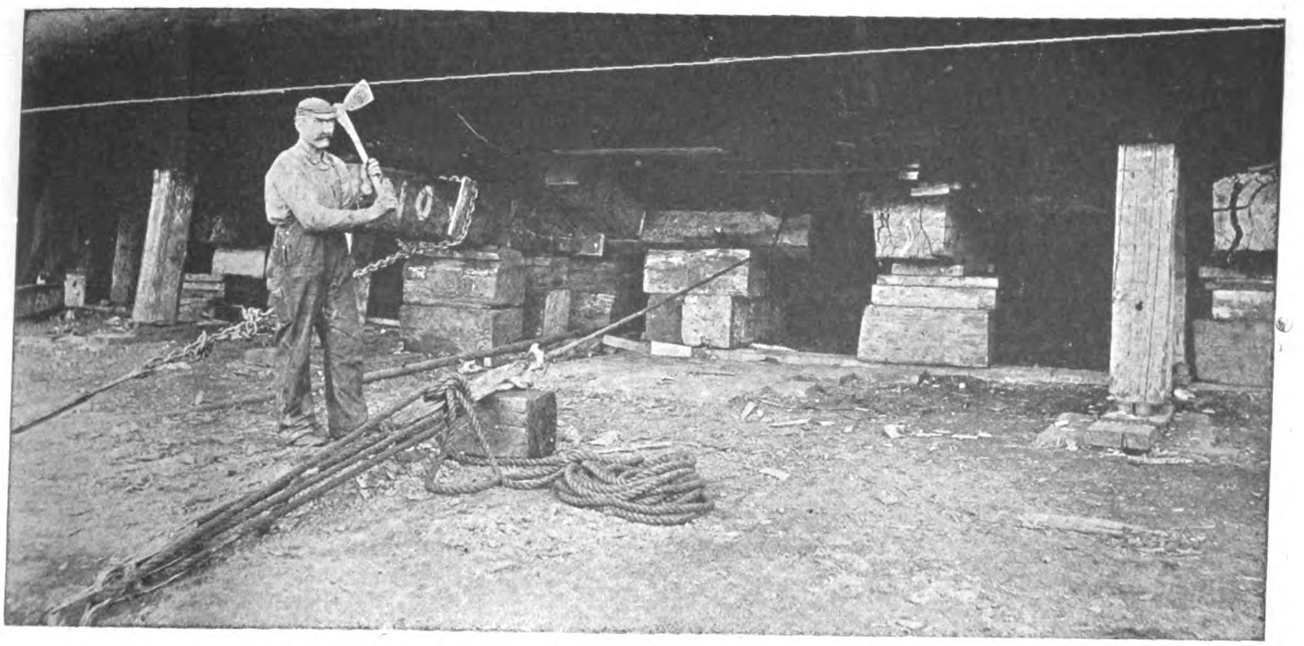

Fig. 6.—Method of Cutting Rope to Release Trigger at Side Launching

two rows and leaves these on the ways, unless all the courses are connected together. Later on, when the No. 1 row passes over the way ends, the hull will drop bodily and, having no blocking under her, will hit the ways.

Where vessels have been blocked up in this manner, an examination of the blocking after the launch will reveal that it is more or less chewed up. Moreover, where there is a considerable drop and the three outboard rows are tied together, the drop of the hull is very evident from the way the blocking is thrown about and scattered by the hull landing on these courses while in a listed position.

Fig. 2 shows a vessel just after she has lost the support of the keel blocking and tipped on the No. 1 course. The height of the dock edge above water is 3 feet 6 inches, which, with an 18-inch way, makes a drop of 4 feet 6 inches. This is not an unusual case so far as lake practice is concerned, but it appears that the hull must list to an angle of 18 degrees before it even touches the water. When the dock edge is at the water level, this angle will reduce to about 9 degrees or one-half the previous angle.

Fig. 1 shows the No. 1 course placed midway between the centerline and the outboard courses, on 7-foot 6-inch centers. This is for a ship 43 feet wide and is perhaps general practice. On the placement of these courses it would seem better to increase the distance of the No. 1 row from the centerline rather than diminish it, as this will give more assurance of clearing the ways when the No. 1 course is dropped.

Another circumstance to be avoided as far as possible is that of having any of the double-bottom tanks full at the time of launching. In some cases this may be necessary for the purpose of stability, when special provisions in the blocking must be made. The water should be restricted to those tanks within the fore and aft limits of the critical row of blocking. It is readily seen how the presence of a body of water beyond the terminal blocks will modify the load curve and additionally burden the terminal blocks and contiguous hull.

Inspection of Metallic Electrode Arc Welds

Two Methods of Testing Welds—Haphazard Welding Versus Correct Procedure—Method of Placing Deposited Layers Plays Important Part on Internal Strains

BY O. S. ESCHOLZ*

DETERMINING the character of welded joints is of prime importance, and the lack of a satisfactory method, more than any other factor, has been responsible for the hesitancy encountered among the engineering profession towards the extensive adoption of arc welding. To overcome this prejudicial attitude it is eminently desirable to shape our rapidly accumulating knowledge of operation into an acceptable method of inspection.

Manufactured apparatus is practically all accepted on the basis of complying with a process specification rigidly enforced in conjunction with the successful reaction to certain tests applied to the finished product. Riveting, it is commonly known, seriously impairs the strength of the joined plates, yet with a proper layout and intelligent inspection, the completed structure possesses certain definite characteristics which do not require further verification. The inspector of a finished concrete structure is practically helpless. That the weakest sort of construction may be concealed by a sound surface is quite possible. With a careful supervision of the process, however, the physical properties of the completed structure can be reliably gaged to the extent that its use is justified even in ship construction. With this in view, it is satisfying to realize that electric arc welding is susceptible to even

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better control than either of these structural operations.

How to Determine the Character of a Weld

The four factors which determine the physical characteristics of the metallic electrode arc welds are: fusion, slag content, porosity, and crystal structure.

Some of the other important methods that have been suggested and used for indicating these characteristics are:

(1) Examination of the weld by visual means to determine:

(a) Finish of the surface as an index to workmanship.

(b) Length of deposits, which indicate the frequency of breaking arc, and, therefore, the ability to control the arc.

(c) Uniformity of the deposits, as an indication of the faithfulness with which the filler metal is placed in position.

(d) Fusion of deposited metal to bottom of weld scrap as shown by appearance of under side of welded joint.

(e) Predominance of surface porosity and slag.

(2) The edges of the deposited layers chipped with a cold chisel or calking tool to determine the relative adhesion of deposit.

(3) Penetration tests to indicate the linked unfused zones, slag pockets and porosity by:

(a) X-ray penetration.

(b) Rate of gas penetration.

(c) Rate of liquid penetration.

(4) Electrical tests (as a result of incomplete fusion, slag inclusions and porosity), showing variations in:

(a) Electrical conductivity.

(b) Magnetic induction.

These tests if used to the best advantage would involve their application to each layer of deposited metal as well as to the finished weld. This, excepting in unusual instances, would not be required by commercial practice in which a prescribing welding process is carried out.

Of the above methods the visual examination is of more importance than generally admitted. Together with it, the chipping and calking tests are of particular usefulness. The latter test serves to indicate gross neglect by the operator of the cardinal welding principles, due to the fact that only a very poor joint will respond to the tests.

Penetration Tests

The most reliable indication of the soundness of the weld is offered by the penetration tests. Obviously, the presence of unfused oxide surfaces, slag deposits and blow holes will offer a varying degree of penetration. Excellent results in the testing of small samples are made possible by the use of the X-ray. However, due to the nature of the apparatus, the amount of time required and the difficulty of manipulating and interpreting results, it can hardly be considered at the present time as a successful means to be used on the large-scale production.

The rate that hydrogen or air leaks through a joint from pressure above atmospheric to atmospheric, or from atmospheric to partial vacuum, can readily be determined by equipment which would be quite cumbersome, and the slight advantage over liquid penetration in time reduction is not of sufficient importance to warrant consideration for most welds.

Kerosene (paraffin), of the various liquids that may be applied, has marked advantages, due to its availability, low volatility and high surface tension. Due to the latter characteristics, kerosene (paraffin) sprayed on a weld surface is rapidly drawn into any capillaries produced by incomplete fusion between deposited metal and weld scarf, or between succeeding deposits, slag inclusions, gas pockets, etc., penetrating through the weld and showing the existence of an unsatisfactory structure by a stain on the emerging side. A bright red stain can be produced by dissolving suitable oil soluble dyes in the kerosene (paraffin). By the means of this test, the presence of faults have been found that could not be detected with hydraulic pressure or other methods. By the kerosene (paraffin) penetration, a sequence of imperfect structures linked through the weld, which presents the greatest hazard in welded joints, could be immediately located. It must be borne in mind, however, that this method is not applicable to the detection of isolated slag or gas pockets, nor small, disconnected unfused areas. It has been shown by various tests, however, that a weld may contain a considerable amount of distributed small imperfections without affecting, to a great extent, its characteristics.

If a bad fault is betrayed by the kerosene (paraffin) test, it is advisable to burn out the metal with a carbon arc before rewelding under proper supervision. By the means of sand blast, steam, gasoline (petrol), etc., large quantities of kerosene (paraffin) are preferably removed. No difficulty, however, has been encountered on welding over a thin film of the liquid.

Electrical Test Methods

Electrical test methods, by which the homogeneity of welds is determined, are still in the evolutionary stages. Obvious difficulties are yet to be overcome before the electrical test is feasible. Some of the difficulties are the elimination of the effect of contact differences, the influence of neighboring paths and fields, and the lack of practicable, portable instruments of sufficient sensitivity for the detection of slight variations in conductivity or magnetic field intensity. No simple tests are possible, excepting those which involve subjecting the metal to excessive stresses, for determining the crystal structure. Control of this phase must be determined by the experience obtained from following a prescribed process.

The inspection of metallic arc electrode welds may consider that through the proper use of visual, chipping and penetration tests a more definite appraisal of the finished joint may be secured than is possible in either riveting or concrete construction. The operation may be still further safeguarded by requiring rigid adherence to a specified process.

Good Results Are Assured if Correct Procedure is Followed

Haphazard welding can no sooner produce an acceptable product than hit-or-miss weaving will make a marketable cloth. It is only logical that all the steps in a manufacturing operation should be regulated so as to obtain the best possible result. As it is, and most unfortunately, most welders consider themselves pioneers in an unknown art that requires the exercise of a peculiar temperament for its successful evolution. As the result welding operators enshroud themselves in the hallow glow of an expert, do their work with a mysterious camouflage bewildering to the untutored. Once in a while, due to we might say, coincidences, these "experts" are successful in obtaining a good weld, but more often the good weld is attributable to the friction between slightly fused plastered deposits.

In common with all other operations, metallic electric arc welding is really susceptible to analysis. Regardless of the metal welded with the arc, the cardinal steps are (1) Preparation of weld; (2) electrode selection; (3) arc current adjustment; (4) arc length maintenance; (5) heat treatment.

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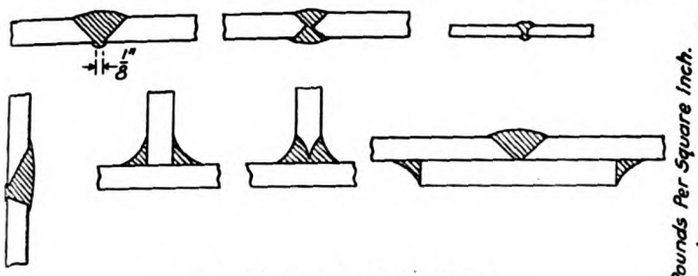

Fig. 1.—Typical Arc Weld Scarfs

Sufficient scarfing is involved in the preparation of the weld, as well as the separation of the weld slants, so that the entire surface is accessible to the operator with a minimum amount of filling required. When necessary to avoid distortion and internal stresses due to unequal expansion and contraction strains, the metal is preheated or placed so as to permit the necessary movement to occur. Various types of scarfs in common use are shown in Fig. 1.

The electrode selection is determined by the mass, thickness and the constitution of the material to be welded. An electrode free from impurities and containing about 17 percent carbon and 5 percent manganese, has been found generally satisfactory for welding low and high carbon, as well as alloy steels. This electrode can also be used for cast iron and malleable iron welding, although more dependable results, having a higher degree of consistency and permitting machining of welded sections, can be obtained by brazing, using a copper aluminum iron alloy electrode with the aid of some simple flux. Successful results are obtained by brazing copper and brass with this electrode. The diameter of the electrode should be chosen with reference to the arc current used.

Fig. 2

Fig. 3

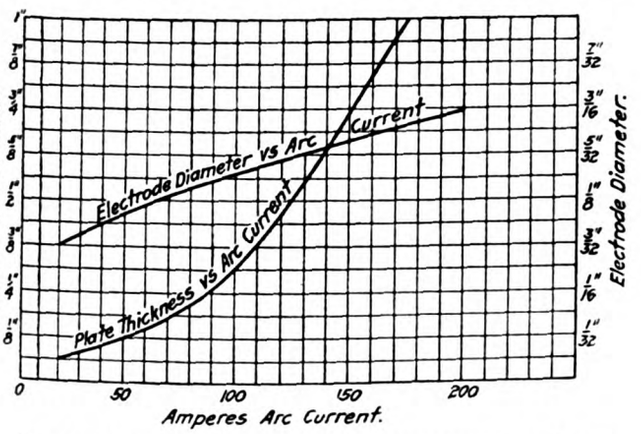

Fig. 4.—Chart Showing Approximate Arc Current and Electrode Diameters for Welding Steel Plate of Various Thicknesses

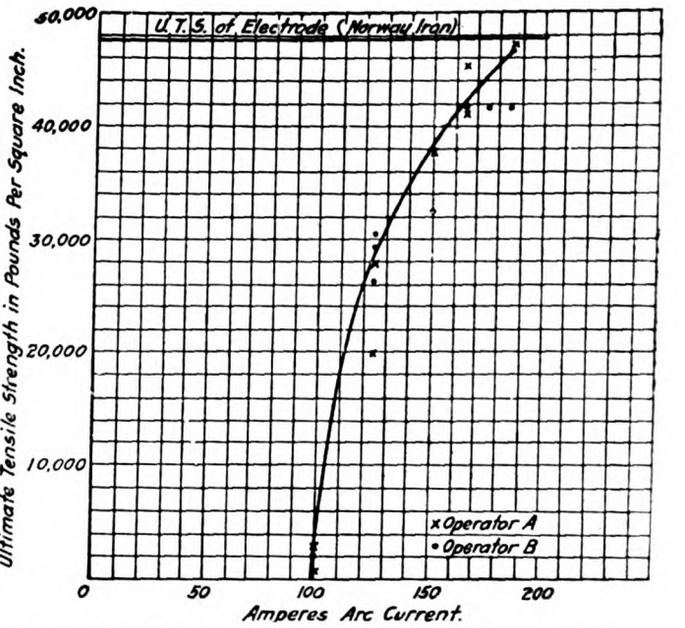

Fig. 5.—Variation in Weld Strength With Change in Arc Current

The Effect of Too Low Current Values

A great many concerns have attempted welding with too low an arc current, and the result has been a poorly fused deposit. This is due largely to the overheating characteristics of most electrode holders, on using current value, and thus leading the operator to come to the conclusion that the current used is in excess of the amount needed.

Fig. 2 shows a section through one-half of an exposed joint welded with the proper current, while Fig. 3 shows the effects of too low a current. The homogeneity and the good fusion of the one may be contrasted with the porosity and the poor fusion of the latter. (These surfaces have been etched to show the character of the metal and the welded zone.)

The approximate values of arc current to be used for given thickness of mild steel plate, as well as the electrode diameter for a given arc current, may be taken from

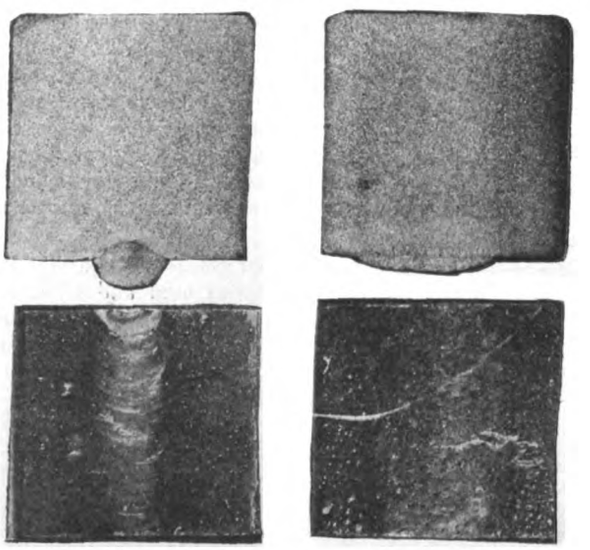

Fig. 6

Fig. 7

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the curve in Fig. 4. The variation in the strength of 1-inch square welded joints as the welding current is increased is shown in Fig. 5.

Notwithstanding that the electrode development is still in its infancy, the electrodes available are giving quite satisfactory results. However, considerable strides can yet be made (with its further evolution) in the ductility of welds, consistency in results, as well as in the ease of utilizing the process.

The maintenance of a short arc length is imperative. A non-porous, compact, homogeneous, fused deposit on a 1-inch square bar from a short arc is shown in Fig. 6, while in Fig. 7 is shown a porous, diffused deposit from a long arc. A short arc is usually maintained by a skillful operator, as the work is thereby expedited, less electrode material wasted, and a better weld obtained, due to improved fusion, decreased slag content, and porosity. On observing the arc current and arc voltage by meter deflection or from the trace of recording instruments, the inspector has a continual record of the most important factors which affect weld strength, ductility, fusion, porosity, etc. By the use of a fixed series resistance and an automatic time lag reset switch across the arc it is possible to fix definitely both the arc current and the arc voltage, and thus placing these important factors entirely beyond the control of the welder and under the direction of the more competent supervisor.

The method of placing the deposited layers plays an important part on the internal strains and distortion obtained on contraction. It is possible that part of these strains could be relieved by preheating and annealing, as well as by the allowance made in preparation for the movement of the metal.

Heat Treatment and Inspections

The heat treatment of a completed weld is not a necessity, particularly if it has been preheated for preparation and then subjected to partial annealing. A uniform annealing of the structure is desirable, even in the welding of the small sections of alloy and high carbon steels, if it is to be machined or subjected to heavy vibratory stresses.

The inspector, in addition to applying the above tests to the completed joint and effectively supervising the process, can readily assure himself of the competency of any operator by the submission of sample welds to ductility and tensile tests or by simply observing the surface exposed on cutting through the fused zone, grinding its face and etching with a solution of 1 part concentrated nitric acid in 10 parts water.

It is confidently assumed, in view of the many resources at the disposal of the welding inspector, that this method of obtaining joints will rapidly attain successful recognition as a dependable operation to be used in structural engineering.

Internal Bossing for Cargo Vessels

Structural Changes Proposed Where Strength and Savings in Space and Cost are of Vital Importance

BY E. DE BRINJA

DURING the war the shipbuilding here and abroad took a remarkable step forward so far as output, efficiency and new designs were concerned. Experiments were made on unsinkable ships, concrete boats, ships having cruiser sterns, and on twin-screw cargo vessels.

The bossing used on twin- and quadruple-screw steamers and motorships, however, did not change to any appreciable extent. This fact does not necessarily indicate that improvements cannot be made in design which will save space, labor and money. As a matter of fact, quite a lot of study has been devoted to the development of the matter, and some of the changes proposed in ship bossing are incorporated in the accompanying sketches. These sketches give a general idea of the bossing for cargo ships, where strength, space and money savings are the most important factors to be considered. Of course certain structural parts, such as fastening castings to bulkheads, frames and shells, will alter somewhat according to local conditions.

Before we discuss proposed changes, let us consider the present outside bossing, the material used and labor expended before it may be fitted on the ship. The table below indicates the material used and shops where it is put in shape for use:

Material	Shops	
Hull connection casting	Pattern shop, Foundry, Machine shop	Hull drawing room, Engine drawing room
Stuffing box casting	Pattern shop, Foundry, Machine shop	Hull drawing room, Engine drawing room
Pipe for connecting both castings	Pipe shop	Hull drawing room, Engine drawing room
Bossed frames	Mold loft, Smith shop	Hull drawing room, Engine drawing room
Bossed shell plate	Mold loft, Plate shop	Hull drawing room, Engine drawing room
Fairwater plates	Mold loft, Plate shop	Hull drawing room, Engine drawing room

By the foregoing table it will be noted that six pieces are used to build up the present bossing and that the material has to go through fifteen shops before it is ready to be fitted on the ship. Now let us compare the proposed bossing with this:

Material	Shops
Casting	Hull drawing room, Engine drawing room, Mold loft, Pattern shop, Foundry, Machine shop

Only one fitting is used, and a very remarkable saving of time, labor and expense is apparent.

The brackets used come out with the frames, so that these do not have to be considered.

Naturally there are other points to be considered in addition to those given above:

Is this a strong construction?

Is there enough bearing surface?

Is the proposed construction sufficiently light?

Is the distance between the strut arm and the bossing too great?

What effect on eddy-making will the shaft have where it leaves the hull?

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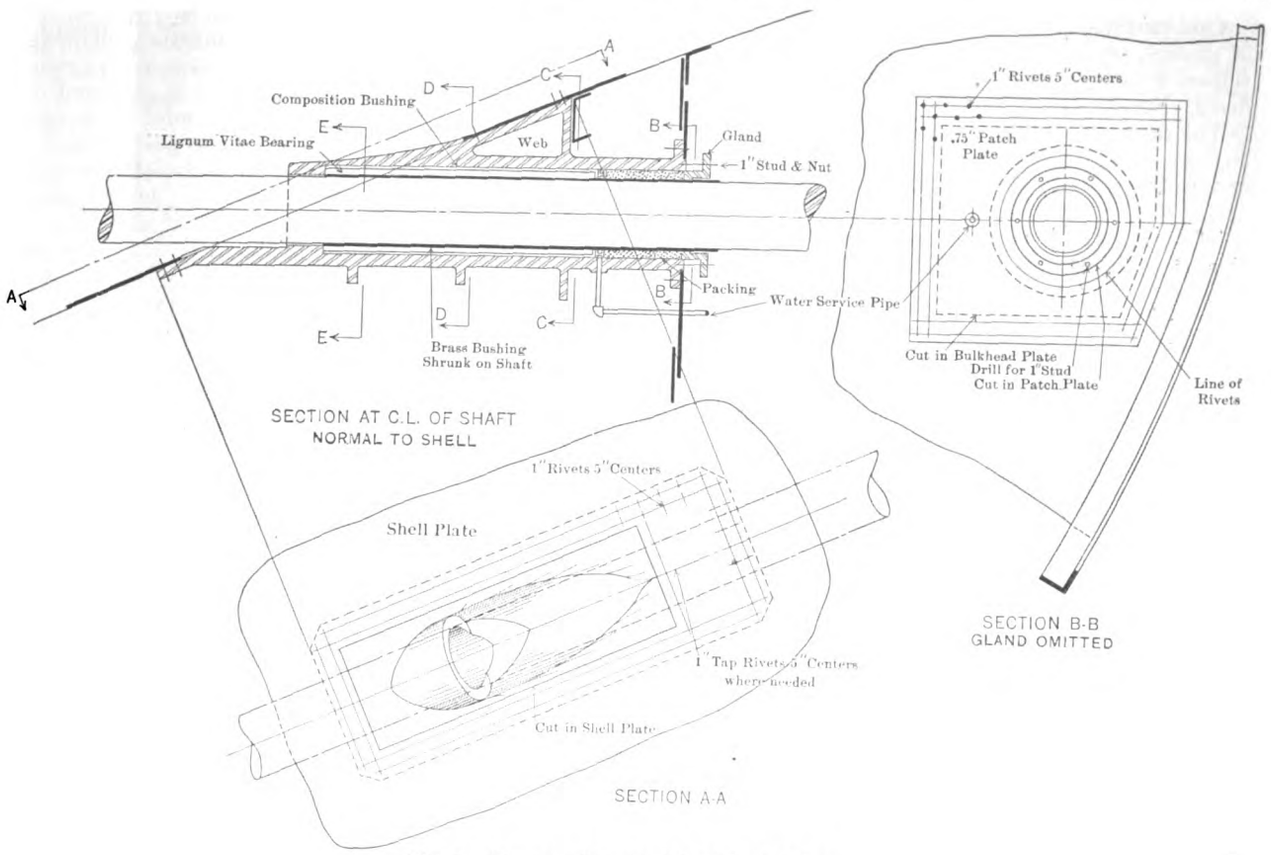

Fig. 1.—Changes Proposed in Ship Bossing

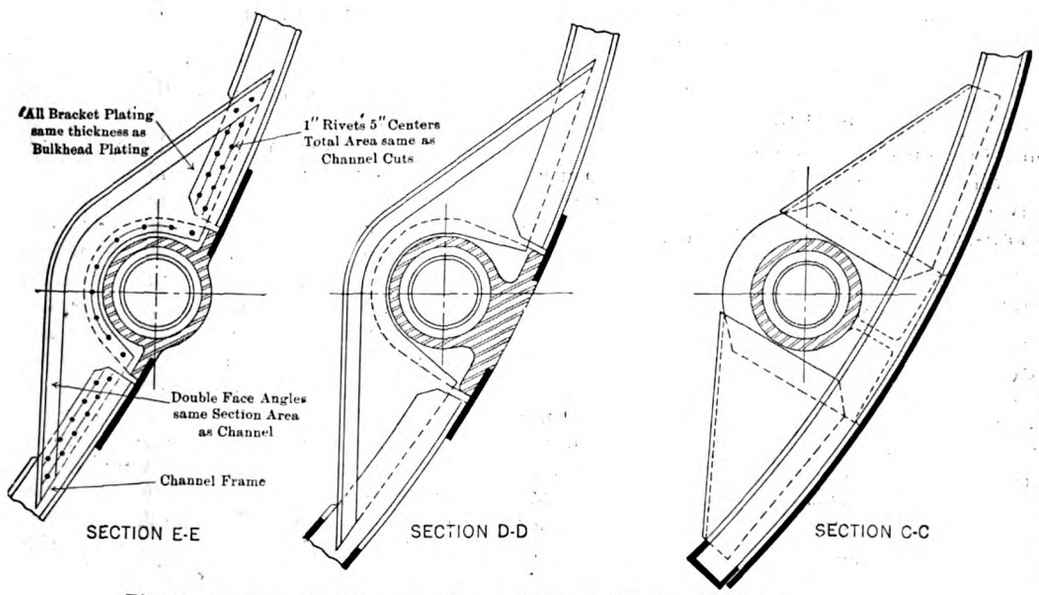
All Bracket Plating same thickness as Bulkhead Plating
1" Rivets 5" Centers Total Area same as Channel Cuts
Double Face Angles same Section Area as Channel
Channel Frame
SECTION E-E
SECTION D-D
SECTION C-C

Fig. 2.—Sections Showing Structural Details of Internal Bossing

How much lost cargo space is caused by this construction?

As we investigate these questions we find that the construction will be stronger, as the connection of the casting to the hull, frames, bulkheads, etc., is on the inside of the vessel and may be reinforced to suit conditions. Webs in the casting, brackets, angles and plates may be used freely without having to look out for eddy-making or any other kind of resistance.

The bearing surface may be made as large as desired—about four diameters of the shaft plus the length of the stuffing box.

It must be evident to all that the weight of the proposed bossing will be less than the outside bossing, inasmuch as it consists of only one casting and a few brackets, while the other includes two separate castings, a tube, fairwater plates and bossed frames.

The length of unsupported shafting between the bossing and the strut arm will be found to be safe, if the distance is not greater than 30 diameters of the shaft, which is very seldom the case in cargo vessels with block coefficient of 0.74, or at least over 0.70.

The eddy-making and residuary resistance is practically negligible, as the hull is fair and the shaft round, and no fairwater plates are needed. The wetted surface is also slightly decreased.

The cargo space lost is less than in the present construction, as the entire casting of the internal bossing is only about as large as the casting connecting the outside bossing to the hull.

The casting is made of steel with webs and flanges, sufficiently strong to stand the strain. Its thickness, of course, depends on the size of the ship and the horsepower.

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One continuous frame is fitted to the casting by means of staunch brackets (Section C-C), while in places where frames are cut, solid brackets with double-face angles are fitted, riveted to the frames and flange of the casting.

The smallest sectional area through the bracket and face angles must be at least as great as the area of the frame, and sufficient rivet area should be given (Section D-D and E-E).

The cut in shell plating may be altered to suit conditions, but the casting should be recessed to take the shell plating. The latter is chain-riveted to the casting (Section A-A).

A heavy patch plate is fitted on the bulkhead, to which the casting is riveted. Sufficient space should be left between the shell and the patch plate to allow for calking. Means of access is provided in the bulkhead so the casting may be removed without cutting the bulkhead.

Minor details, as the stuffing box, water service, bearings and bushings, will be the same as practiced now.

This bossing should prove to be useful in the construction of cargo ships and "full" passenger steamers of the future. The term "full" is used advisedly because in a "fine" line steamer the distance of unsupported shaft might be too great and an additional shaft arm would have to be fitted. This method, of course, would lose the advantage of labor and money saving that we have tried to accomplish with the new bossing.

The primary object of this design is to lower the cost per ton, which is so high now, without affecting the quality, strength and workmanship of the construction.

Sequence of Mold Work in the Loft

System Adopted at the McDougall-Duluth Shipyard for Getting Out Material for Standard Lake Type Cargo Steamers

BY J. A. RIDLEY*

THE following is a programme arranged at the McDougall-Duluth shipyard by the writer a year ago to handle the mold loft work in getting out the single-deck type of standard cargo steamers as built in various yards on the Great Lakes. It was arranged with a view of bringing into simple routine the many items involved (where the whole hull is made from the loft) in their regular order to suit fabrication and erection. While certain conditions made it impossible to follow the programme exactly, nevertheless it proved useful, and may be of interest to those having similar jobs to do.

Briefly, the first operation was fairing up the lines, which has so often been explained, then lifting finished offsets on sheets of paper to transfer them onto the body plan so as to scratch in all the transverse frames. The body plan must be very well prepared in this case and every item carefully spotted in with paint, which proves an economy of time before completion of the whole job.

The Body Plan

On the body plan (always termed scrieve board in England) mark all the plate edges with the sight edge prominent, including all the cut off at the top of the bulwarks to the extreme ends of the ship, also all decks or flats, stringers, floor heights, tank margins and brackets, sections of side and center keelsons and girders, sections of casings, deck houses, coal chutes, hatches, boiler stools, engine girders and beam cambers at bulkheads and intermediate parts a few inches apart, using the beam mold made at this time.

Next lay off the cant frames and clearly scratch and paint in their projections on the body plan. Also spot paint all the extremes, as stem and stern post contour lines, a short distance at the stern and stem on the main floor. The clear marking and inclusion of all these fixed items minimizes the chance of error or neglect in taking care of connections to each other. This immediately establishes the outlines, and time and mental efforts are saved in a reduction of continual reference to other drawings.

In mold work it is necessary to start on the keel and center vertical keelson at the same time with the angles, excepting the flange to the tank top; in fact, many of the dead flat molds could be well under way using the midship frame only. Finish the keel to the extreme ends with molds and forms to bend the same, and also the center keelson with the termination brackets, and finish all clips to same throughout. Carry along the dead flat bottom shell first, and if you get an early start, finish expanding the whole of the shell. The exact position of all the land holes will then be secured so that it will be possible to get every hole in the frames and its correct line on the stem and stern frame for landing the scarph and tuck molds, and to have a chance to revise the shell orders to eliminate errors and scrap.

In any loft it is a good plan to lift all shell records for expansion from the body plan, either on strips carefully stored and indexed, or, better, in dimensions on a loose-leaf record book, with every necessary particular in tabular form at one operation, so that it will be possible to go apart anywhere to develop the shell clear of the body plan, and enable frames and other numerous particulars to proceed without interruption. Make an early start on the smith molds for the bilge floor frames and mark the bevels, also molds with all the holes in for marking the stern post, tuck plate and stem. Make your efforts tend to produce at an early stage of the work all that affects the installation of machinery, which will also increase the speed of launching and delivery of the ship.

To avoid a long cluttering up of the floor, start a separate arranging of flange strips for the tank top stiffeners, center keelson intercostals, boiler stools, engine foundation, tunnel and shaft stools and other tank top connections. It is not a bad plan, with a scarcity of floor space to make a longitudinal strip arranged for butts that can be used right across on the tank top edge laps to avoid laying down a monopoly of large pieces.

Laying Out Tank Top Connections

With the floor molds made, it is possible to finish the tank top stiffeners, top angles of the center keelson, intercostal side girder margin clips both square and with bends. Take care of the special gage for the latter, and angle collars to watertight floors. Lay out all tank top plating using the aforesaid strips, and also the margins connecting thereto in conjunction with the above. If the shell is

* Inspector, Emergency Fleet Corporation.

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finished, the margin angles can also be finished, leaving short blank pieces to drill outside where the three ply at crossing shell laps occur. Make smith molds for the upper bilge angles and mark the bevels on them. Then continue with the side frames, starting at midships, and fix universal holes for the beam brackets, bilge brackets or other connections and bevels, and complete the bilge brackets with the frames ready to mark off, leaving the beam brackets until later. Gather tank connections of boiler stools, engine and thrust foundations, shaft tunnel and stools and recesses, mast and pillar brackets, all auxiliary foundations and lay out and finish molds for these items completely, finishing all angles on the tank for early testing of compartments affecting the installation of machinery. Lay out and complete molds for all internal bulkheads, including the bunkers and angles connected thereto, except deck flanges. Lay off and template all panting stringers, web frames and swash plates, lower flats, chain lockers, beams and pillars below the main deck, deck runners and girders and other such internal items.

Get out molds for the strong beams early, including the hatch end plates, and hatch coamings with all connections. Start a separate arranging of beam strips midships for the main deck. Sometimes it is best to expand the whole thing on the floor temporarily and arrange the butts of plates, etc., and record the whole on the above strips, and the new expanded stations with butt positions, etc., on longitudinal strips to enable the decks to be layed out later in less portions without such monopoly of floor space. This, of course, is dependent on time, and quantity of help, with floor space. With the strips ready it is now possible to finish the beams and the bulkhead bounding angles at the deck flange. It is advisable to keep the rivets universal gage on both beam and frame for the bracket knee (except at the ends of the ship) and use a bracket hinged on a small rivet at the corner of the deck and skin, and carry this along, marking the change of each beam in the throat or diagonal knee, while holding it to the camber line and frame line. This could be used to lay out the plate knees direct, but later these bracket molds are made of millboard on a bench for outside use, while the other is kept as a record.

Use of Millboard Molds

Millboard is handy for many purposes—as cut-up intercostals, deck girders, partial floors, bilge brackets and all small brackets. Some kinds of millboard can be drilled easily and used just as template wood, which saves much labor. The thinner paper, however, is unsatisfactory. The frames will be nearly finished by this time, so it will be possible to gather the deck strips and lay out all the molds for the main deck stringers and deck plates and fix up the gunwale angles having the shell flange from the plating, also scupper compensation angles and brackets to deck.

Pick up all strips or flanges which have already been laid out and make molds for the engine and boiler casings, first transversely then longitudinally; also coal chutes connecting the same and all hatch coamings, deep under-deck girders, diamond plates, mast brackets, winch flats and foundations, and also the masts with all their attachments, and hold pillars and finish all braces and angles. Lay off all cant molds and fix all bracket and clip connections and follow with expanded and molded counter plates, if not already done in connection with the shell.

The writer finds it best to do these in the way he used twenty-five years ago in England when using drilled templates and to adjust the knuckle to the rail both ways as far as needed, if there is only slight change in the offsets, and use the old quick and true set line method. Lay out molds for all weather deck or superstructure bulkheads, using shell flange strips and deck flange strips to complete all angles for the same. The ventilators should also have been included earlier. In some circular ones it is best to drill flange holes through the deck when placed. Every item on steel doors is also laid out in the loft, such as dogs, slots and hinges punched small to bolt up, adjust and ream.

Prepare strips as before for the bridge, poop and forecastle decks and all deck house and such connections. Scratch the outline of the two endmost decks on the floor and spot paint, then finish all beams and brackets and make molds for all these decks, being careful to include all fittings which have been approved sufficiently to be located at that time, and finish all gunwale and other angles to these decks.

Where there are many hulls off the molds, it will be a good plan carefully to develop the hawse pipe, to get the complete mold from the lines, and also the exact finished size of the holes in both shell and deck for its easy insertion. The most accurate pattern is thereby obtained to fit the many ships. The writer had almost a monopoly in low cost, in replacing broken hawse pipes at Grimsby twelve years ago, and has done many on this continent in addition to anchor pockets in the old way with rod and gage. This is mentioned because the writer feels that many will protest that the above development is impracticable, but in a tangible process clearly understood it takes little time to develop a multitude of lines.

Expand the bulwark rails and lay off molds checking with the shell connection, also the end brackets at bulkhead, and the bulwark stays laid off and molded to position in the body plan. They will correct the rail, with one part small holes bolted, adjusted and reamed. Gather all connection strips and lay off and mold all deck houses on the bridge and also poop deck and boat deck and all beams, stiffeners, brackets and steel doors as previously described. Finish all these to the entire top of the superstructure. Lay out molds to plates in the skylights for galley and engine room, and all their angles and connections.

The steel crosstrees on the mast head can be molded entirely in sections using millboard, and all the molds made for the fresh water tanks, which will about finish the job. This programme was carried out almost in the order named, odd things as usual in shipbuilding were delayed, pending approval, but generally included later. The hawse pipe production seemed deliberately obstructed in approval until too late to be included, although there could have been less error than previously, or less division of responsibility with a definite person to blame.

The shell was almost complete out to the extremes, and where many hulls are built from one set of molds it seems best, after all, to do the most difficult plates from the loft with forms containing a duplicate of the frame holes to pin plates and fasten to exact position at the slab. Such plates are costly to lift and set at the ship, and often have finally to be formed from the loft.

Standardized Marking of Molds

We always aimed at simplifying the billing or marking of molds, by abbreviations and omissions, standardized as far as possible. This was a habit formed in a short period of structural work, which, though better in some ways, is not so cheap in the whole as shipwork. The hull number was billed first, then the particular part of the hull next in exactness, following with the item number in the

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stock sheet, quantity of plates or angles to mark therefrom with poundage and which side up to mark, diameter of holes and particulars of countersinking. While this appears lengthy in description, it only comprises a few letters and symbols, which are kept in one place and do not have to be hunted up all over the template. For example,

Hull No. 14 Shell L-5
1.64 = 1*PL* = 22.8 pounds *T-S-U* = *S*
1.64 = 1*PL* = 22.8 pounds *O-S-U* = *P*
⅞ o Csk. O,

which means hull number 14, on shell the L strake number 5 plate, use stock sheet item number 64, take 1 plate equal 22.8 pounds' weight and mark it with mold this side up for starboard side and the other side up for port side and punch on marks with ⅞-inch holes, and in each case countersink when turned over and inside of these outlines.

Further, all holes were drilled in both wood and paper of constant size ½-inch clear, so that one size punch would mark everywhere. The small holes preserve the strength.

An attempt was also made to keep a record of their use in the yard with dates, and (another very important point) some effort was made at having a proper tallied storage in the loft, with a system of divisions like plate racks for the different strakes of shell, and other distinct sectional parts, not including more in divisions than was easily available for constant reference, in the many connections necessary in this system, which all saves time, gives an easy check to reduce the chances of error and tends to produce success.

Shipping Board Engineers Study Marine Turbine Construction and Operation

Westinghouse Company Conducts School at East Pittsburg—250 Students Take Intensive Six Weeks' Course—Engineers at Sea Given Advice on Operating Problems

WHEN the United States Shipping Board began to operate cargo vessels the want of properly trained officers proved a decided handicap. This was particularly true of the propelling machinery staff, for not only were reciprocating engineers needed in large numbers, but men familiar with the geared turbine drive.

The opening of the turbine schools, where skilled engineers, who had been trained on reciprocating engines, or had in some cases limited experience in the handling of turbines, could be given the latest and most improved instruction under the direction of men thoroughly familiar with the construction and assembling of this type of engine, was immediately considered.

Turbine School Opened

The Board communicated with the leading manufacturers of turbines (Westinghouse, General Electric, De Laval, Kerr, and others) and proposed that classes be established at each plant for engineers who would be supplied by the Shipping Board. The first class was opened in 1918 at the Westinghouse works in East Pittsburgh.

The school was under the official direction of the Board's recruiting service. After the school had been in existence a short time it was placed under the direction of A. A. Gathemann, supervising engineer of turbine training United States Shipping Board recruiting service, who deserves unlimited credit for making this undertaking a decided success.

The students in these schools must be either chief engineers or first assistants. Many candidates applied direct to the recruiting service; others are selected from their staffs by the various ship operating companies; and still others are picked up individually by the recruiting service and turbine manufacturers, either because of personal acquaintance or through correspondence requesting information as to turbine operation.

Fig. 1.—U. S. Shipping Board Marine Engineers Class No. 8. (Back) Sadler, Schloetzer, Field, Frazer, Thornton, McIntire, Sheppard, Tegtmeir, Stewart, Brinkman. (Front) Rattner, Standish, Harleston, Lloyd, Simons, Byrne, Callahan, Roche, Norton, Harrison

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During the course of instruction, which averages about six weeks in length, the students receive liberal shore pay, traveling expenses and an allowance for sustenance. Upon completion of the course, if the student has attained a satisfactory average for all work done, he is awarded a diploma which, although it has no official status, is ample evidence that the holder is qualified to operate marine turbines. Over 250 students have so far been enrolled.

The principal schools are located at the plants of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, and the General Electric Company, Schenectady. All students must take the courses at both of these schools. Afterward those who are to handle some other make of turbine in the immediate future are transferred to the plant of that particular manufacturer.

The Westinghouse Company has developed a very comprehensive course. A. W. Kirton, who is in charge of the

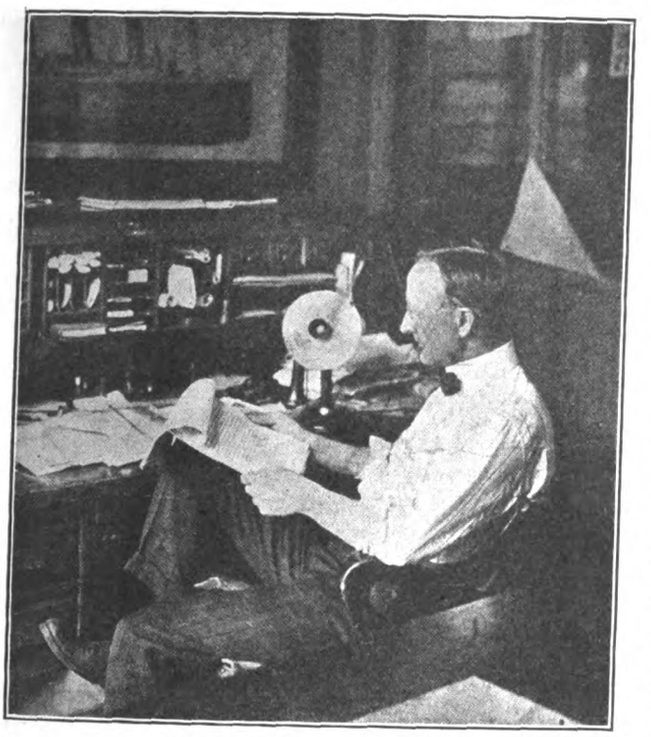

Fig. 2.—A. W. Kirton, in Charge of Westinghouse Marine Turbine School

local school, has been connected with the company for more than twenty years, and has had charge of large foreign contracts in South Africa, Russia and Brazil. Officially he is in charge of the contract inspector's department, handling all visiting inspectors and their contract relations with the company.

COURSE OF INSTRUCTION

The course, which runs through a period of three weeks, is divided into five main subjects: Small turbine drives; condensers and auxiliaries; main turbine; main reduction gears; and electrical equipment.

The class is taken into the shop, in groups of not more than seven or eight to each instructor, and given the opportunity of seeing all the parts of each piece of the various propelling apparatus. Each part is carefully and systematically explained in detail. Great care is taken to explain the reasons of design, where trouble may occur, and how to remedy it. The class is also given every opportunity for taking each piece of apparatus apart and reerecting it, to make sure that each man has a thorough understanding of the construction. The men also go over

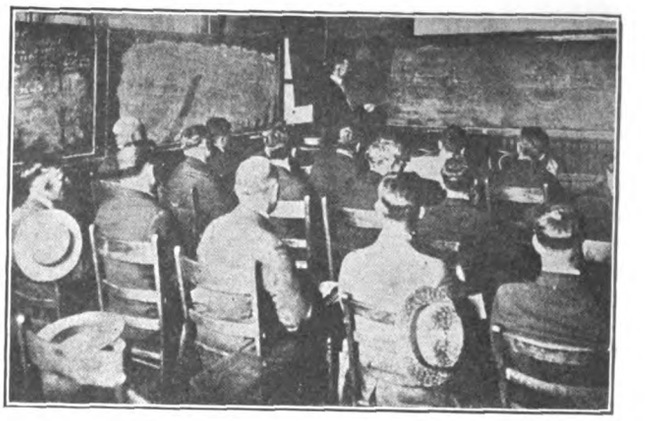

Fig. 3.—Attending a Lecture

all adjustments on the turbines, and do sufficient work on the inserting of turbine blades to know what to do in case of trouble. On the main gears, great care is taken to make the class familiar with all adjustments necessary for alining and operation.

Supplementing this training, lectures are given on each of the above groups by Westinghouse engineers. Practical points of operation are emphasized and fundamental principles brought out. The class is encouraged to ask questions during the lectures.

After the specified time allotted to each subject has expired, examination questions on that subject are given out and written answers handed in. The corrected examination paper is handed back to each student, together with a copy of the correct answers. The students appreciate this method exceedingly, since it gives them a chance of seeing where they are wrong and, by keeping all the official questions and answers together, they have an excellent reference book for future use. Time is provided for reviewing work that is not clearly understood by any student.

The following typical questions picked at random from the various examination papers will show the scope of the course offered:

Why is the diaphragm used between the ahead reaction blades and the astern blading on the high pressure turbine?

Why is it not used on the low pressure turbine nor on the single-cylinder complete expansion turbine?

Why is the balance piston or dummy used?

Describe how you would take blade clearance, stating

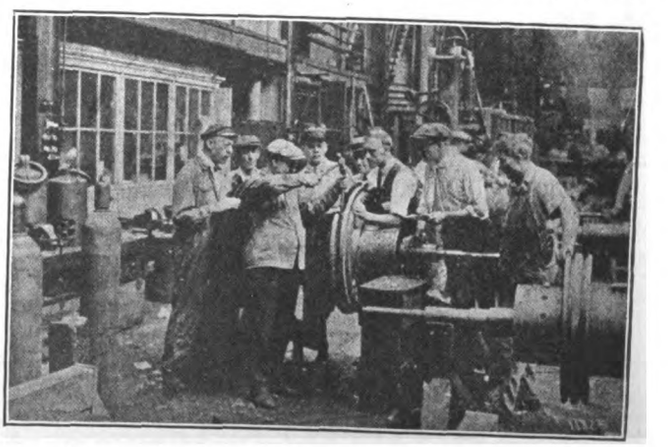

Fig. 4.—Practical Work With a Turbine Spindle

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each move from beginning to take turbine apart to final assembly ready for operation.

Give detailed description of starting and stopping the condensing equipment.

State the different methods of measuring a vacuum.

When the course is completed the student's record is forwarded to the Shipping Board, serving as a true analysis of the student's aptitude and probable ability, which is very useful in finally placing him.

In addition, a grand average is taken of the individual rating, and is known as the "class rating." Rivalry is developed between the classes, which tends to bring out the best efforts of every man.

Personnel of the Classes

The average class consists of sixteen men, usually ranging from 24 to 50 years of age. The men bring to the manufacturing company years of sea experience, and at times give valuable suggestions to the company's engineers. They keep the company's engineers on the alert to answer their very practical questions. Anxious to learn the how and why of the apparatus from the inside, these men make ideal students.

Consultation Encouraged

Every effort is made by the company to impress on all the engineers before leaving that they must not consider their connection with the company severed at the end of their training. They are informed that the company's erection department will keep in touch with them on the ships and give them all the help possible. The men are also invited to visit the works again to keep themselves up to date on all new designs, etc., and are especially asked to keep in touch with Mr. Kirton regarding any engineering problems that may develop on board their ships. Each problem submitted is carefully considered by the company's engineers, and the proper information sent back as soon as possible. Already a number of concrete examples are on file in which the ship engineer has made the operation of his vessel successful by such direct appeal to the manufacturing company.

It is decidedly satisfactory to a chief engineer, thrown on his own resources at sea, to know his apparatus thoroughly, both as to manufacture and assembly. It is equally satisfactory to the manufacturer of the equipment to know that the engineer knows. The combination represents the greatest forward step in satisfactory navigation since the adoption of geared turbine drive on ships.

Proposed Harbor Development at Mobile

IN a preliminary report submitted by William T. Donnelly, consulting engineer, 17 Battery Place, New York, to the State Harbor Commission, Mobile, Ala., important changes in the development of adequate harbor facilities are suggested.

In preparing this outline Mr. Donnelly has made a comparative study of the successful harbors on the Atlantic coast showing that most of the important seaports have grown up as outlets to the natural resources found in the Appalachian mountains. He points out that the southern Appalachian district has only recently been opened for exploitation and consequently that the cities which will develop as the result of this trade are destined for phenomenal growth. He also pointed out that the city of Mobile is the natural outlet for the coal and steel industries in this region and that immediate steps should, therefore, be taken to provide the necessary terminals so that this trade will not be diverted.

The first step toward the adequate handling of freight at this port, Mr. Donnelly said, would be the relocation of the Louisville and Nashville Railroad at a sufficient distance from the waterfront of Farmers Island to permit the building of piers along this front. It will probably be found profitable to rearrange the other railroad lines in order to provide more direct handling of materials from railroads to vessels. Subsequent developments, of course, will prove whether the use of carfloats or direct railroad connection would be the most profitable arrangement.

Protection Against Inundation

The next recommendation of the report advises definite action in providing against inundation by the sea. This would mean the elevation of railroad tracks, piers or other cartage facilities above the Gulf flood level. Such a move would provide permanency of construction which would serve greatly to decrease the liability of insurance companies at these ports, and, consequently, would decrease the insurance rates, a factor which should be carefully considered in relation to economical terminal operation.

Specifically, Mr. Donnelly suggests as preliminary construction work the building of a secure bulkhead on a site now occupied by the Commercial wharf. This construction which should be 1,240 feet long by 118 feet wide would probably cost about $200,000 (£41,000).

As an economical provision for storage facilities it is proposed that a four story concrete fireproof warehouse be built on the new bulkhead at an approximate cost of $1,250,000 (£256,000). By this arrangement three stories would be available for permanent storage, and the pier floor, subject to inundation, could be occupied by temporary cargoes. Mr. Donnelly suggests, however, that future warehouse developments be undertaken by private capital. At a later date he recommends the building of other concrete fireproof piers approximately 800 feet long by 200 feet wide to be covered with fireproof concrete sheds. These piers which would be located between 300-foot slips would cost approximately $1,250,000 (£256,000) each. Mr. Donnelly has suggested that $5,000,000 (£1,025,000) expended over a five year period would be a sufficient fund to carry the construction to a profitable conclusion.

Future Industrial Development

In taking up the possibilities for the future industrial development at Mobile, he emphasizes that this port could well be used as a manufacturing point for imported raw material, such as cabinet woods from California or South America. Mobile would then become a redistributing point for this kind of goods. He also shows that the bark now split from the lumber, which is exported, might be profitably used for the tanning of hides which could be brought in to Mobile from the west.

Such industrial development would mean extensions in all directions. Probably these would first be located inland from the harbor proper. The southern development of the harbor of Mobile toward the bay should not be overlooked, however, but the extension of Blakeley Island to the east and Sand Island to the west of the main ship channel would be considered as reserved for individual development such as the handling of coal and ores, which would require considerable area and specially constructed terminals. The development of this portion of Mobile harbor will require very rugged construction to meet the conditions in the much more exposed location, and its added distance from rail connection will increase the cost of operation. It will therefore be most suitable for the transfer of commodities between river and ocean carriers, either for export or import.

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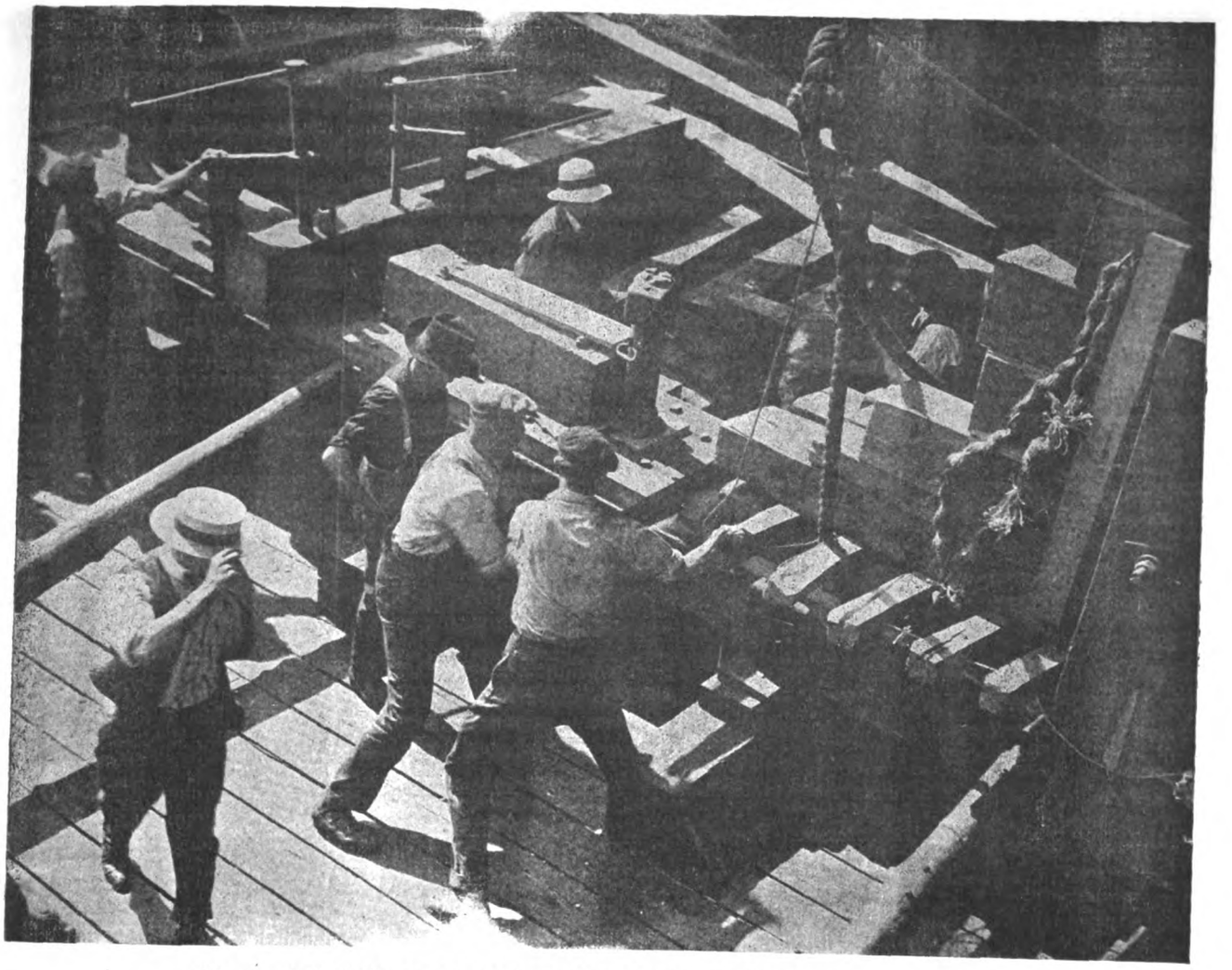

Fig. 1.—Critical Moment at the Launching of a Ship at the Shooter's Island Yard

Swiftest Submarine in the World

The fastest combination submarine in the world has been built at the Fore River plant of the Bethlehem Shipbuilding Corporation at Quincy, Mass. The *AA*-1 built for the Electric Boat Company returned from her recent trial trip with a record for performance that excells any submarine yet built.

The *AA*-1 is 270 feet long, 20 feet beam, 14½ feet draft. On the surface she made 20.75 knots, exceeding her contract by .75 knot. Submerged she made 12.5 knots which is one knot more than required.

The *AA*-2 and the *AA*-3 will soon have their trial trips.

Shop Competition at the Shooter's Island Yard of the Standard Shipbuilding Corporation

CONFIDENCE in the future prospects of shipbuilding has led the officers of the Standard Shipbuilding Corporation at Shooter's Island, N. Y., to plan for a steady programme of building in the future. Improvements have consequently been made in the shops at the yard. The plate shop, boiler shop, blacksmith shop, pipe shop and machine shop have been enlarged while new construction includes an office building containing private rooms, a dispensary, a rigger's loft, tool storage, outside machine shop and a paint shop.

The various shops in the yard have carried on a keen competition in construction and equipment. Complete equipment for the ships building at the yard is now provided by the boiler shop, machine shop, blacksmith and pipe fitting shops.

The boiler shop has reached the point where it is able to produce one complete single-ended three furnace Scotch boiler (14 feet inside diameter) fitted with a heated draft system, per week. All boilers are built for 190 pounds pressure.

In three and one-half weeks the machine shop has completed the engines and auxiliaries for one ship. This equipment includes one 3-crank triple expansion engine with cylinders 25 inches, 41 inches and 70 inches diameter by 48 inches stroke, developing 2,500 indicated horsepower; a main surface condenser having 3,500 square feet of cooling surface; one auxiliary condenser with 500 square feet of surface; one 14-inch centrifugal circulating pump and its power unit; a single cylinder 10-inch by 10-inch engine; one direct connected air pump; two 5-inch by 20-inch direct connected bilge pumps. In addition independent pumps have been built as follows:

One 4½-inch by 3¾-inch by 4-inch feed water pump.
One 10-inch by 14-inch by 16-inch ballast pump.
One 12-inch by 8½-inch by 12-inch fire bilge and general service pump.
One donkey engine feed pump, one evaporator, one feed water heater and one forced draft fan.

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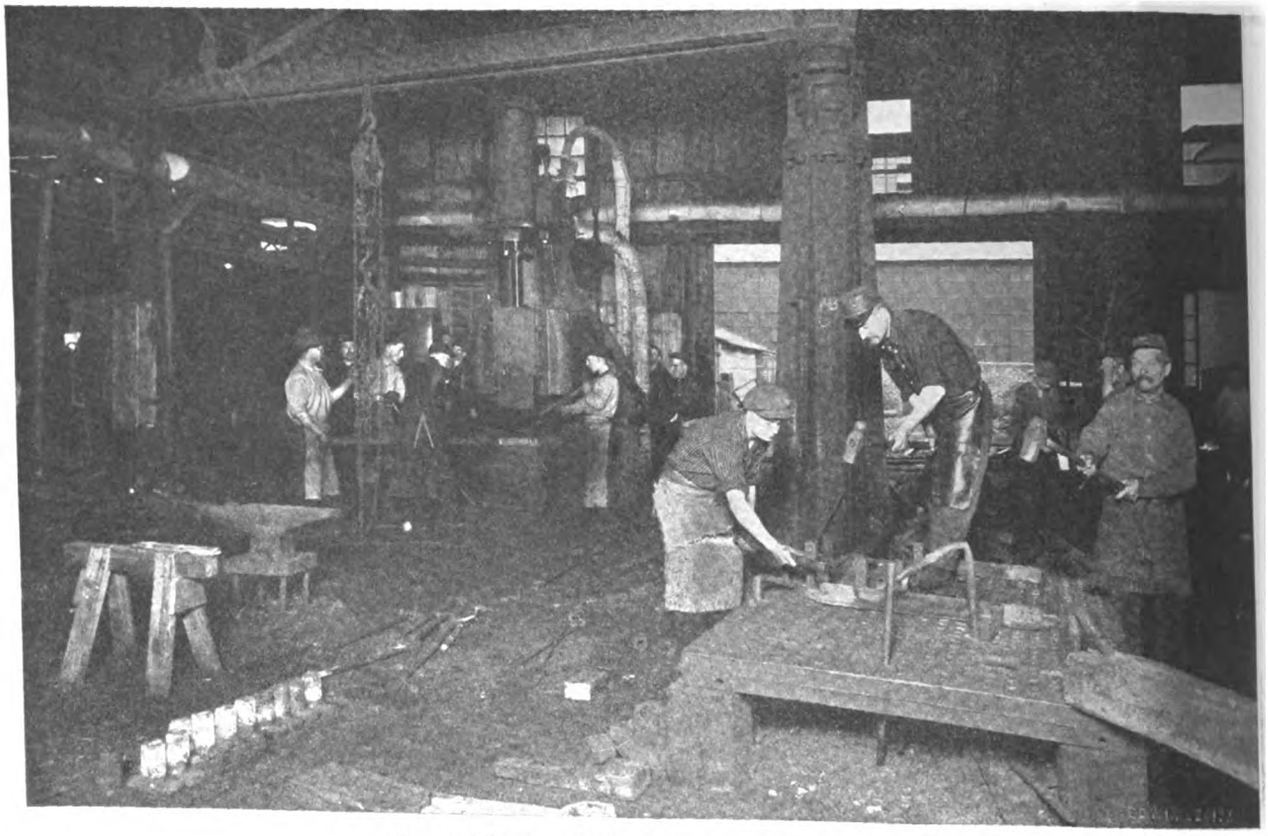

Fig. 2.—Blacskmith Shop at Shooter's Island Yard

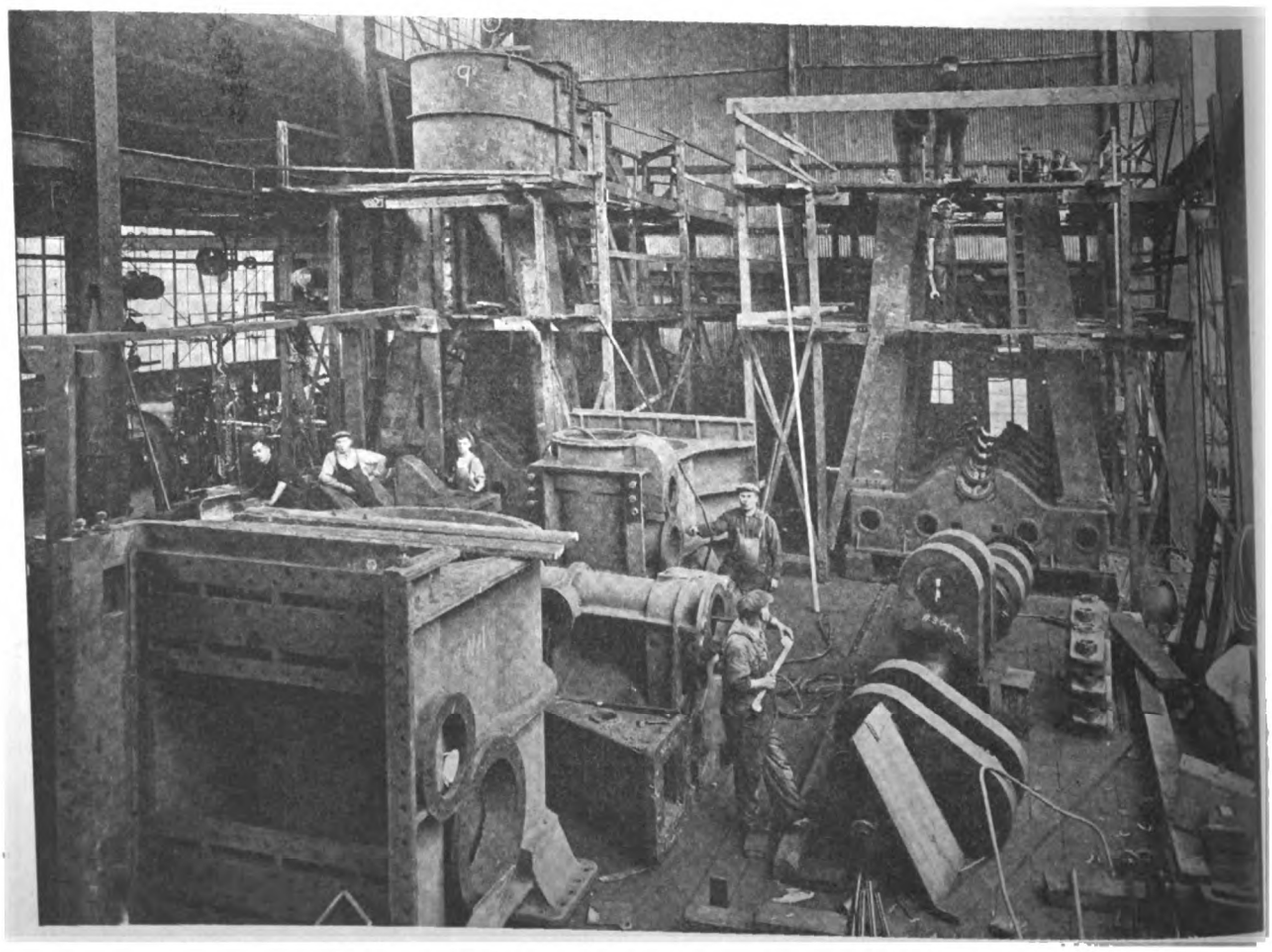

Fig. 3.—Assembling Floor in the Shooter's Island Machine Shop

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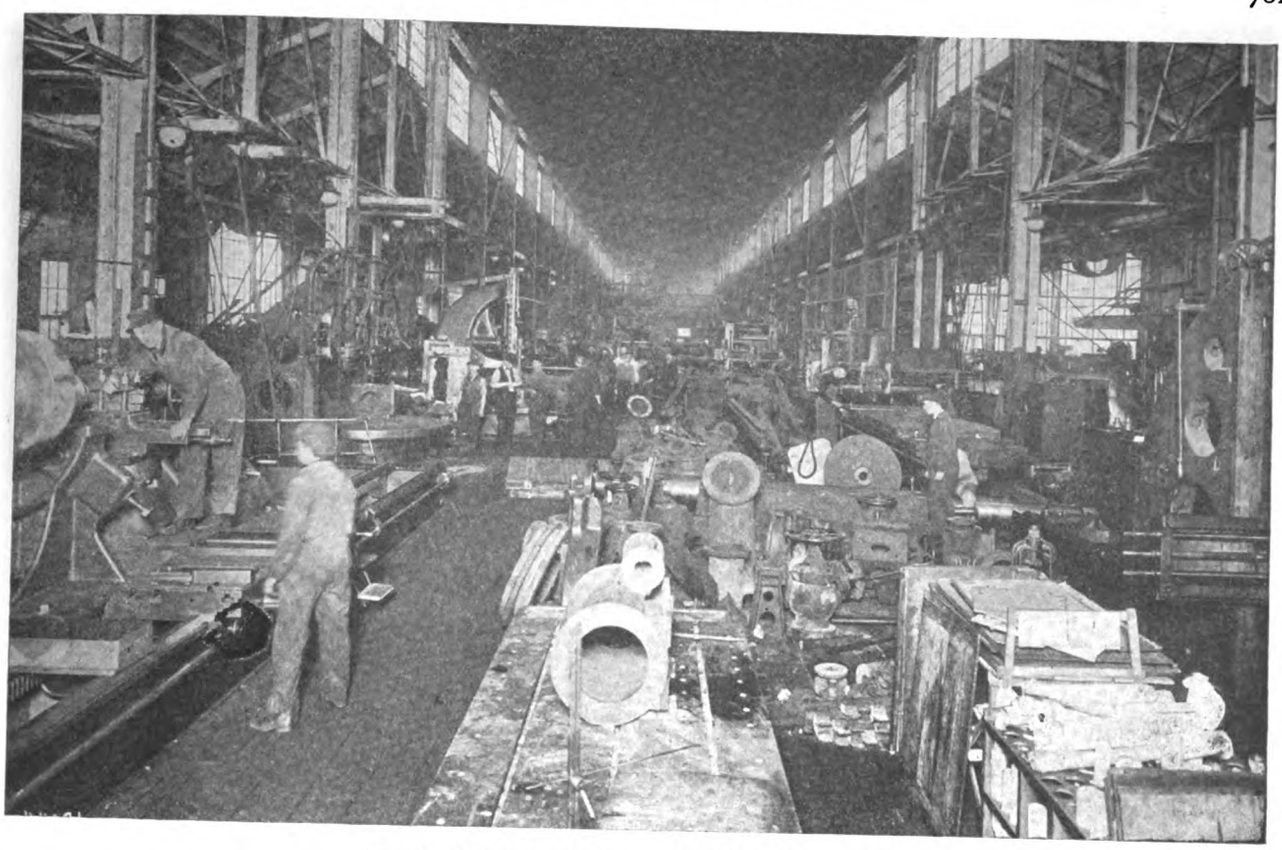

Fig. 4.—Main Bay in Shooter's Island Machine Shop

Fig. 5.—Where Propeller Shafting is Manufactured for the Standard Ships Built on Shooter's Island

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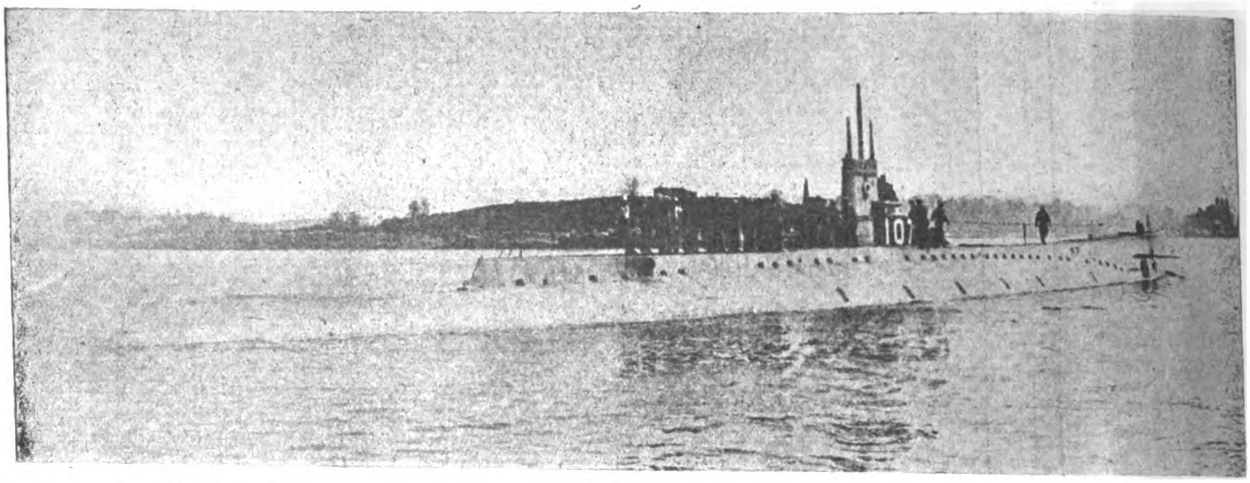

Fig. 1.—U. S. Submarine, 800 Tons Displacement; Speed, 15 Knots on Surface, 12 Knots Submerged

Electrical Equipment on Submarines

Propelling Machinery Consists of Two Separate Motors Combined in One Unit — Method of Control — Auxiliary Motors

FEW pieces of electrical apparatus are more difficult to design than the motors of submarines. These motors must not only propel the boat when it is submerged, but must also start the engines and act as generators for charging the batteries during surface cruising. They must be of the utmost reliability, as they are in almost constant use; they must be highly efficient at all speeds so as to permit as large a cruising radius as possible from a battery charge; and they must be practically noiseless for military reasons. Their weight and the space they occupy must be at a minimum for their horsepower capacity, and their dimensions must conform to the confined space into which they are crowded. The internal parts must be thoroughly protected from oil and water, but at the same time they must be well ventilated, to prevent overheating, and be as accessible as circumstances permit.

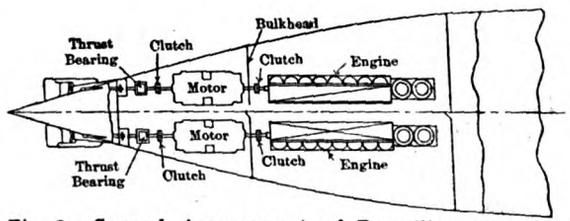

Fig. 2.—General Arrangement of Propelling Machinery

The motors built by the Westinghouse Electric & Manufacturing Company for the latest type of United States submarine, shown in Fig. 1, illustrate how these conditions have been met.

Construction of Motors

As shown by Fig. 2 there are two motors to each submarine. Each motor is coupled to a Diesel engine at its forward end and to a propeller at its aft end. When the motors are driving the boat the engines are uncoupled, and when the engines are used they drive the propellers through the motors, the armatures of the latter either turning idly or generating current to charge the batteries. The motors are similar in design, and each is rated at 600 horsepower for continuous operation at 260 revolutions per minute and 220 volts.

The special feature of this type of motor is that it really consists of two motors, forming a single compact unit. As shown by Fig. 5, there are two armatures, mounted on a common shaft and as shown by Fig. 6, there are two separate field windings carried by the frame. This arrangement results in a long and narrow outline, which is well adapted to the space available for installation, and it also provides certain advantages in control, which will be explained later.

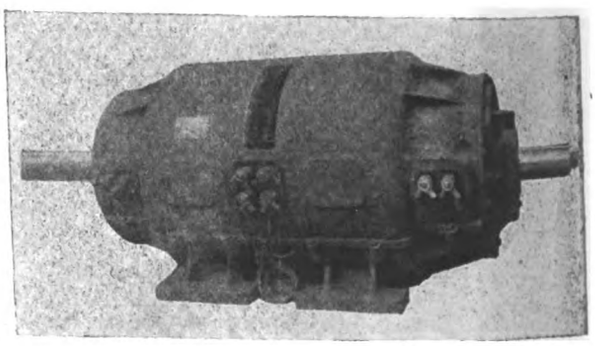

Fig. 3.—Inboard Side of Propulsion Motor

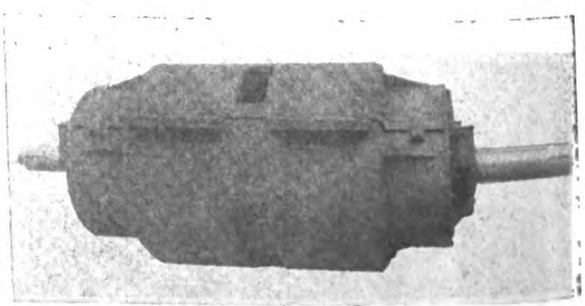

Fig. 4.—Outboard Side of Propulsion Motor

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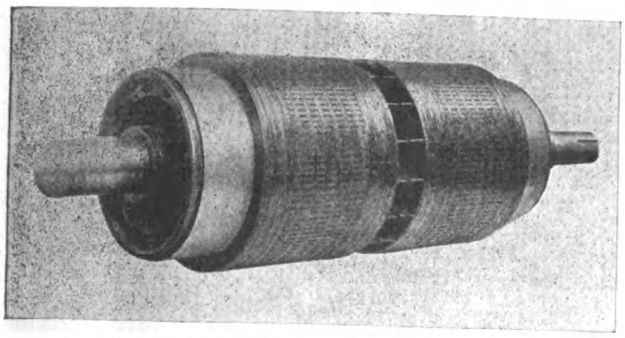

Fig. 5.—Double Armature of Propulsion Motor

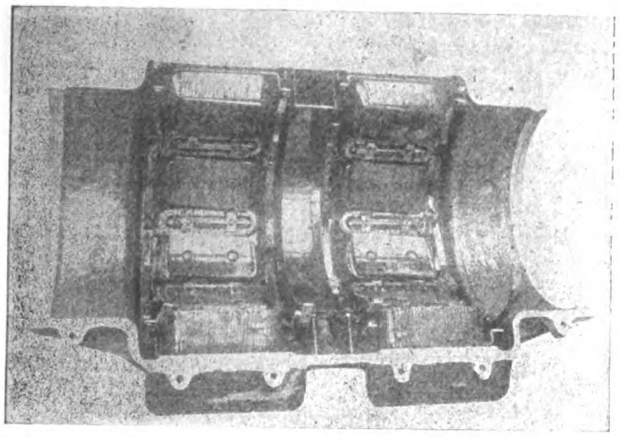

Fig. 6.—Motor Frame, Showing Two Sets of Field Coils

The frame entirely encloses the motor and is split at an angle of 30 degrees from the horizontal so the upper part can be removed in the low head room. The feet are also arranged at the same angle so as to fit the hull of the vessel. Forced ventilation is furnished by a motor-driven blower (not shown in the illustrations) which is mounted directly above the motor. The air enters the slot in the frame shown in Fig. 4, is directed in its proper path by a sheet steel duct shown in Fig. 6 and emerges through the slot shown in Fig. 3.

The bearings are carried in the solid end brackets and are of the sleeve type lubricated by oil and waste similar to railroad practice. Arrangements are made to prevent oil from leaking into the windings.

The main field consists of a shunt winding with a light series winding to produce a drooping speed characteristic, which provides for a satisfactory division of the load between the two armatures when operating in parallel. Commutating poles are placed between the main poles to suppress sparking at the commutator. The main poles are slightly skewed, as shown in Fig. 6, to reduce the noise of operation.

Hand holes are provided in the frame which give access to the brushes and commutators, and the brushes are mounted on a rigging which can be revolved so that all of the brushes can be inspected through the holes.

CONTROL

The clutches connecting the shaft with the engine and with the propeller are so designed that the motor thrust-bearing has to carry only the thrust due to the weight of the armature and the clutches when the boat dives at an angle. The propeller thrust is carried by a special thrust block.

Because of the variety of combinations that can be obtained by connecting the two armatures of each motor

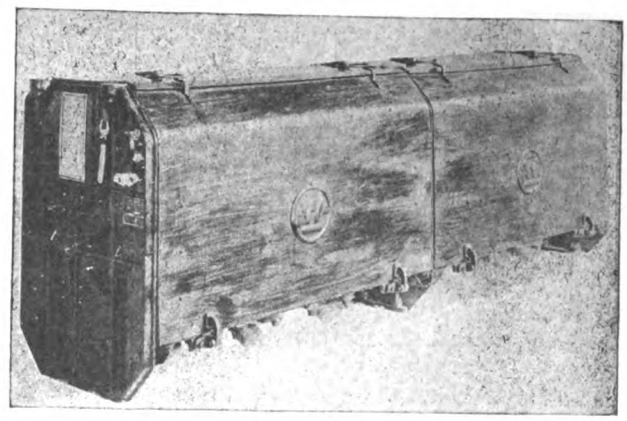

Fig. 7.—Exterior of Switch Group

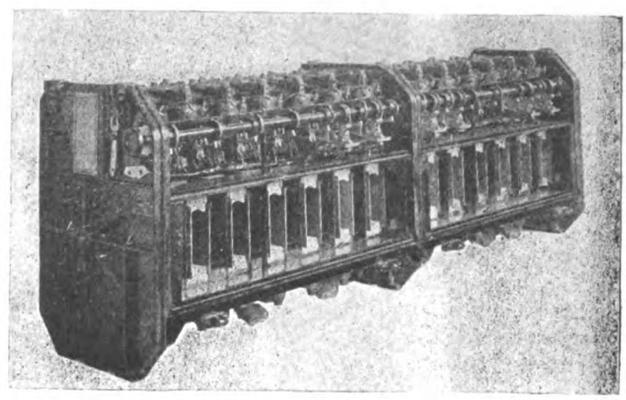

Fig. 8.—Switch Group with Cover Removed

unit in series or parallel and by dividing the 120-cell storage battery into two parts, connected in a similar manner, a wide range of economical speeds can be obtained without installing extra units.

For high speeds the two sections of the battery are connected in series and the motor armatures in parallel, thus

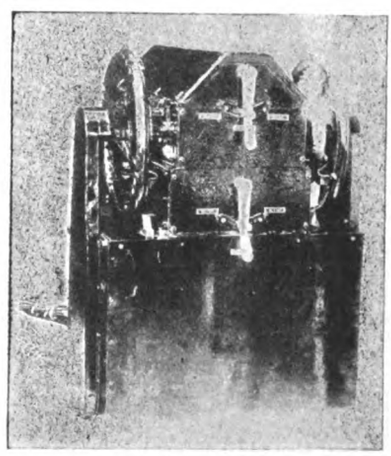

Fig. 9.—Master Controller

impressing full voltage on each armature. For medium speeds the battery sections and the armatures are both connected either in series or in parallel, giving the armatures half voltage in both cases. For low speeds the battery sections are in parallel and the armatures in series, so that each armature receives one-quarter voltage. With each of these connections a range of intermediate speeds is available through the use of field resistance.

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Interlocked electrically operated switches are used for controlling most submarines, but some of the latest types are controlled by an electro-pneumatic system.

This system comprises two main parts: a switch group for each motor unit, shown in Figs. 7 and 8, which makes the actual connections, and the master controller, Fig. 9, which controls the operation of the switches for all of the motors, either when propelling the vessel or when charging the batteries.

The switch group which is mounted in the motor room of the submarine consists of fourteen switches, which make the connections for cutting out the resistance in starting the motors and for reversing. Each switch is operated by compressed air, but the air valve of the switch is controlled electrically by the master controller, so that by opening or closing a contact on the master controller the corresponding switch in the switch group is opened or closed. This system is a modification of that used in controlling electric locomotives.

The master controller is located in the central operating compartment of the vessel. The motor units are controlled by the hand-wheels mounted on the sides of the controller. When one of these wheels is turned to the starting position (indicated by a dial and a pointer), a control drum within the controller is turned so as to close the contacts which operate the proper switches of the switch groups to start the corresponding motor. These switches close in the proper order, cutting out the starting resistance and bringing the motor up to speed. Further manipulation of the hand wheel changes the speed of the motor, reverses it, or stops it. Another set of drums within the controller arranges the connections so that the two armatures of each motor can be connected in either series or parallel; these drums are interlocked with the hand-wheels so that they can be moved only when the hand-wheels are in the off position.

Two handles are shown mounted on the front of the controller. These arrange the connections so that either of the armatures of each motor unit can be cut out in case of accident and the propeller operated by the other one.

Provision is made for operating the switches manually in case the electric master control circuit is interrupted.

Auxiliary Motors

In addition to the propelling motors, the following auxiliary motors are required for the class of submarine being described:

AUXILIARY MOTOR EQUIPMENT OF A TYPICAL MODERN UNITED STATES SUBMARINE

Number per Boat	Application	Horsepower Each
2	Air compressor and ballast pump	45
2	Engine circulating water pump	10
1	Anchor windlass	10
1	Steering gear	7.5
1	Oscillator generator	7.5
1	Adjusting pump	7.5
2	Main motor ventilating fan	5
1	Stern diving rudder	4
1	Bow diving rudder	3
3	Periscope hoist	3
1	Wireless generator	3
1	Engine lathe	3
1	Radio mast hoist	1.5
1	Bilge pump	1
2	Lubricating oil pump	1
1	Fuel oil pump	1
1	Sounding machine	½
1	Drill press	¼
1	Grinder	¼
1	Refrigerating machine	¼
7	Hull and battery ventilating fan	¼
3	Hull ventilating fan	⅛

Some of these motors must be watertight, others semi-enclosed, and others can be open, depending upon their application. The constant-speed motors, such as those driving the pumps, are started by means of automatic starters with push button control. For the adjustable-speed motors, such as those driving the fans, manually operated speed controllers are generally used.

The control of the diving and steering mechanism is so arranged that if the electric circuits fail manually operated controls are automatically thrown into gear. The rudders and diving planes are equipped with limit switches, which stop the motors operating them when the limit of travel is reached.

Electricity is also used on submarines for signalling, telephoning, discharging torpedoes, driving the gyro-compass, operating the radio outfit and the submarine listening devices, and for lighting, heating and cooking.

Skinner & Eddy Building Four 10,400-Ton Freight Vessels

THE Skinner & Eddy Corporation, Seattle, Wash., is now building four 10,400-ton deadweight cargo vessels according to plans developed by the company's engineers, James Barclay, C. N. McCallum and Melville H. Kiel. The ships are being constructed under the supervision of Lloyd's and the American Bureau of Shipping. The new vessels will be 439 feet 9½ inches overall, 425 feet between perpendiculars, have a beam of 55 feet and a molded depth to the shelter deck of 36 feet. Loaded they will draw 26 feet 9 inches of water; at peak load the draft will be 27 feet 4 inches.

Three Scotch boilers, 14 feet 9 inches in diameter and 11 feet 9 inches long, will be installed. These boilers, each with a heating surface of 3,000 square feet, are built for 210 pounds working pressure. The General Electric Company's geared turbine engines of 3,000 shaft horsepower will be installed. The vessels are designed to maintain a speed of 12 knots.

Four 5-ton booms will be provided at each mast, two to each hatch, with a 3-ton boom at the mizzen hatch. An additional 30-ton boom, with winches operated by compound gearing, will serve hatch number two for heavy lifts.

These vessels are of the shelter deck type, with three steel decks, five cargo holds and a deep water ballast tank aft of the machinery space which may be used for stowing cargo. Fuel oil, carried in the double bottom, is sufficient to provide a steaming radius of about 10,000 miles. The fore and aft peak tanks provide additional fuel storage to bring the steaming radius up to 13,000 miles. Copper will be used for salt water pipes, feed pipes and exhausts. Steam pipes will be composed of steel with forged steel flanges. It is estimated that the first of these vessels will be ready for launching about January 1, 1920.

The American Steamship Association has unanimously endorsed the resolutions adopted by the National Merchant Marine Association which provide for the sale of steamers of less than 6,000 tons to American or foreign interests; the sale of the larger ships to American citizens within two years on a deferred payment plan; the exemption of earnings of vessels purchased from the Shipping Board by American interests from excess profits taxes, and the assistance of the Government in the construction and operation of new passenger tonnage.

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An American Load Line

BY CAPTAIN C. A. MC ALLISTER, U. S. C. G. (Retired)

The necessity for immediate load line regulation in this country, as provided in Senate Bill 575, is emphasized in the following article and in this connection an account of the development of similar legislation in Great Britain serves as an instructive background for a study of the situation here.

STRANGE as it may appear, there is no official load line for American merchant vessels. That the United States alone, among all the leading maritime nations of the world, has not officially recognized the vital importance of this means for the protection of the life and property of its citizens on the seas may only be ascribed to the general apathy into which this country has drifted for the past forty years concerning all maritime matters. Fortunately for all concerned, the great impetus given to our merchant marine, as an incident of the world war, has now brought this and kindred subjects acutely to the forefront. From surface indications, at least, relief is in sight.

> In an average-sized vessel . . . a difference of even one inch in the location of the load line means a difference of approximately 50 tons of cargo which may be carried. Five or six inches of difference when capitalized into freight revenue might be a sufficient differential to exclude an American vessel from the keen competition which always exists in the ocean carrying trade in normal times. . . . It is probable that international comity has prevented unjust discriminations against American vessels in foreign ports on this account, but there are well-defined rumors to the contrary. . . . Such a condition is most untenable from an American standpoint.

Origin of Plimsoll Marks

It is well to approach this subject from an historical standpoint. There seems to be, even among shipping men, an idea that some countries—notably Great Britain, because of her predominating influence in maritime affairs—have had a recognized load line for nearly a century. This is not so. The first governmental restriction on the loading of ships was not enacted until 1875.

It appears that the subject had been bruited for a long time, and complaints made that unnecessary loss of life at sea had occurred, due to the greediness of shipowners for increased revenues manifested in the overloading of their vessels. This sentiment for the safety of seafarers was finally crystallized into legislation by Parliament, fathered by the late Samuel Plimsoll, and embodied in the Merchant Shipping Act of 1875. His legislative efforts have immortalized him among seamen, as the disks and lines painted on the sides of ships to indicate the safe depth to which seagoing vessels may be loaded are now almost universally known as "Plimsoll Marks."

This initial governmental regulation was grossly inadequate to the demands, inasmuch as it was to remain in force for one year only and was applicable only to foreign bound vessels. Presumably this provision was for experimental purposes and the restrictive features were incorporated incidentally to appease the inevitable opposition to new regulatory provisions of law which are construed by the unthinking and unpatriotic as invasions of private rights. However, the merits and justice of the regulation must have appealed to the majority of people interested, for in 1876 an amendatory act was passed making the affixing of load line marks on all British vessels obligatory on the part of the owners, except certain small craft under 80 tons register engaged in the coasting or similar trades. Even this extension of authority failed lamentably, since no regulations were passed indicating where the load line should be fixed, and the carrying out of this regulation was still optional with the owners. After the load line was affixed, however, it was declared to be illegal for the vessel to be loaded beyond that limit. To show the laxness of such a law, it is related that one facetious shipowner actually placed the Plimsoll Mark on the smokestack of his vessel.

Compilation of Freeboard Tables

There were no further legislative enactments in Great Britain until the year 1890. In the meantime, however, the shortcomings of the then existing laws had become so apparent, especially in view of the power given to the Board of Trade in 1873 to prevent the sailing of ships overloaded, that it was found necessary for that body to work out in a scientific manner certain tables of freeboard, in order that it might exercise judicially the power thus vested by Parliament. These tables were not published until 1882—in the same year British Lloyds issued tables on the same subject. These tables were adopted in 1883 by the Board of Trade. To the credit of many shipowners these tables were voluntarily adopted, and either of the above institutions affixed the load lines in accordance with the tables compiled. This arrangement worked out so satisfactorily that in 1890 an act was passed making it obligatory that the load lines be affixed in accordance with the Board of Trade rules in use at the time of the passage of this act. Under the provisions of the same legislation the Board of Trade was authorized to appoint British Lloyds and any other approved agency to certify for the Board the position of the load line. Under this authority the Board appointed British Lloyds, the British Corporation and the Bureau Veritas as its agents for the purpose intended. Other leading maritime nations have, in substance, adopted the same procedure.

Revision of Load Line Tables

The Board of Trade under the act of 1890 was empowered to accept certain modifications in the then existing rules, upon representations made to its agencies for the affixing of load lines by authorized agencies where ships of exceptional construction were involved, with the inhibition that such changes must be made with great skill, care and judgment. With the disappearance of old types of vessels, the substitution of new types and conditions, and the general advance in the art of naval architecture, this permissive statute was judiciously invoked, and in 1906 all such modifications were embodied in the revised rules of the Board of Trade, which have continued in force up to this time. The general effect of the revised table was to permit certain types of vessels where

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greater precautions for seaworthiness had been taken to carry greater loads than would have been possible under the previous tables. A committee to investigate the effect of this revision of the Board of Trade rules and to consider a further revision has made a most comprehensive report on the whole subject of load lines, taking into account the casualties and loss of life both before and after the 1906 revision. In general, it may be said that this revision was wholly beneficial, as indicated by slight decreases in both casualties and losses of life, as well as an increase in cargo carrying capacities in certain vessels. Most of the facts contained in the foregoing historical references are taken from this report.

It is needless to rehearse for the technical reader the advantages to be gained by load line legislation in this country, but for those not cognizant of the effect of such governmental regulations it may be pointed out that, aside from the universally admitted protection to life and property, which the safe loading of carriers by sea helps to insure, there are other reasons for such enactments. The success of the operation of vessels at sea depends most largely upon the revenue received from the amount of freight carried. The affixing of a load line mark is a restriction upon the depth to which the vessel may be loaded, and consequently upon the weight of the cargo carried.

In an average-sized vessel, such as has been or is now being built by our Shipping Board, a difference of even one inch in the location of the load line means a difference of approximately 50 tons of cargo which may be carried. Five or six inches of difference, when capitalized into freight revenue, might be a sufficient differential to exclude an American vessel from the keen competition which always exists in the ocean carrying trade in normal times. Under existing conditions such a state of affairs is entirely possible, and, it may be added, probable.

While the load lines now unofficially fixed on many American ships operated by the Shipping Board are recognized by our port authorities in allowing vessels to sail to foreign ports, there is nothing in the law or practice which requires any foreign port officials to recognize the load lines on these American vessels when sailing from such ports to our own shores. Also, there are no statutes which would prevent foreign vessels from sailing from our ports, even if laden beyond their load lines. It is probable that international comity has prevented unjust discriminations against American vessels in foreign ports on this account, but there are well-defined rumors in shipping circles to the contrary. Such a condition, it may be admitted by all concerned, is most untenable from an American viewpoint. Some American vessels have had lines affixed through the agencies of foreign classification societies in this country, and these vessels, since they are recognized by the British Board of Trade, have no difficulties, and probably will have none.

To Americans interested in shipbuilding, ship insuring and operating, this lack of legislation has been a matter of serious concern for many years. Although spasmodic attempts have been made to remedy conditions in this respect, nothing tangible has been produced. True, in 1916 a conference of all concerned was called by the Secretary of Commerce and a committee of prominent technical men was appointed to draft the necessary bill, but in the general confusion in maritime matters which resulted upon our entrance into the World War no action has yet been taken. Fortunately, however, there are now pending similar bills introduced by Senator Fletcher in the Senate and Representative Alexander in the House, which, if enacted, will be a long step in the right direction.

All maritime nations have practically agreed upon the load line rules as proposed and revised by the British Board of Trade from time to time. This agreement, however, has no legal status, and to obviate this the International Conference on Safety of Life at Sea held at London in 1913 unanimously agreed on behalf of the nations there represented that as soon as convenient there would be a further international conference to discuss and adopt a standard of load line fixing throughout the maritime world. War conditions have up to this time effectually prevented such a gathering, but it is highly probable that at no very distant date such a conference will be called. For the United States to enter such a conference with no legally adopted system of load line fixing would indeed be a serious handicap, and this condition adds another to the many reasons for immediate action on this important subject. So far as is known, all parties concerned, including the executive branches of the Government having cognizance, have agreed upon the terms of the pending bill.

There is ample technical talent in this country for formulating and discussing the many intricacies entering into scientifically prepared rules for load line fixing, and it is in the interest of the shipping fraternity of this country that Congress signifies its early approval of legislation, in order that designers and ship operators may have time to prepare an American presentation of views concerning this vital concomitant of a successful merchant marine.

The New Load Line Bill

The salient features of Senate Bill No. 575 are as follows:

(a) Makes load line regulation applicable to cargo-carrying vessels of 500 gross tons and upwards loading at any port in the United States for a foreign voyage.

(b) Makes load line regulations applicable to any American cargo vessel loading at any foreign port for any voyage.

(c) Makes load line regulations applicable to any other American vessel loading at any port, where, in the judgment of the Secretary of Commerce, the safety of ship and crew requires the establishment of a legal load line.

(d) Provides that the Secretary of Commerce appoint the American Bureau of Shipping, or any other corporation or association selected by him, as agents in the affixing of load lines.

(e) Provides that reciprocal relations be established with foreign countries regarding mutual recognition of load line fixing.

(f) Authorizes the collectors of customs to withhold clearance papers from any American or foreign vessel, when loaded in violation of the load line acts at home or abroad. Provides penalties for violators.

(g) Provides penalties for illegally changing or obliterating load line marks fixed in accordance with law.

(h) Makes the act effective within six months of the date of its passage.

Latest British Destroyer

The *Witherington*, a new and powerful destroyer was delivered to the British Admiralty on October 10. This vessel was built by J. Samuel White & Company, Ltd., East Cowes, Isle of Wight. The ship, which has a displacement of 1,450 tons, attained on her trials a speed of 35 knots. Her propelling machinery consists of two Brown-Curtis geared turbines and oil-fired White-Forster watertube boilers. The same type of boiler is installed on the world's fastest vessel, the United States destroyer *Cole*, which has a speed of 41.1 knots. The *Witherington* is the seventy-first torpedo vessel completed at the White shipyards.

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Design Departments of Bethlehem Shipbuilding Corporation Centralized at Bethlehem

Drafting Departments of Five Companies Consolidated—Hull and Machinery Divisions Subdivided to Expedite the Work

WHEN the Bethlehem Shipbuilding Corporation, Ltd., was formed in October, 1917, by a consolidation of the shipyards that now make up the five plants of the company, the central office was established at Bethlehem, Pa. Here are located the executive, financial, purchasing, and engineering departments of the corporation. The principal plans for the hulls and the machinery of the vessels constructed at the various yards are prepared at Bethlehem, thus making the standardization of detail parts possible, with the resultant economy in construction cost. Designs for improvements and extensions to the different plants are also prepared at the central office.

Organization of the Technical Department

The amount of work handled in the engineering departments at Bethlehem necessitates the employment of an exceptionally large corps of draftsmen and designers. This force has been built up around the technical organizations transferred from the consolidated companies. The consolidation of these five plants, representing a variety of work constructed by both east and west coast methods, requires at the central office an organization which is capable of handling every kind of marine work, ranging, in the mechanical field, from the smallest auxiliary to the largest turbine, and, in the architectural field, from the small tug boat to the largest type of naval craft.

The technical department, in charge of a technical manager, is subdivided into the hull division, under a naval architect, and the machinery division, under a chief engineer. Under the naval architect an assistant naval architect handles the Government work, another assistant the merchant work, and a third assistant is in charge of new designs and specifications. Each man is the active, responsible head of his division. The machinery division is similarly organized; four assistant engineers under the chief engineer are responsible for the machinery for Government installation, merchant machinery, auxiliaries and electrical work. In general, each assistant naval architect or assistant engineer has his chief draftsman directly in charge of the work in the drafting room.

For handling the actual work in the drafting room, the squad system is used, each squad of draftsmen being in charge of a supervisor who is capable of taking care of the designs of hull or machinery for an entire vessel or a definite part of a vessel. As far as possible the men are given an opportunity to work upon designs in which they are especially experienced.

Process Tracings Distributed to the Yards

Designs for vessels are distributed to the shipyards on "process tracings" made from the original tracings, which are retained at the central office. This method of distribution obviates the necessity of sending out a large number of blue prints and also makes it possible to make

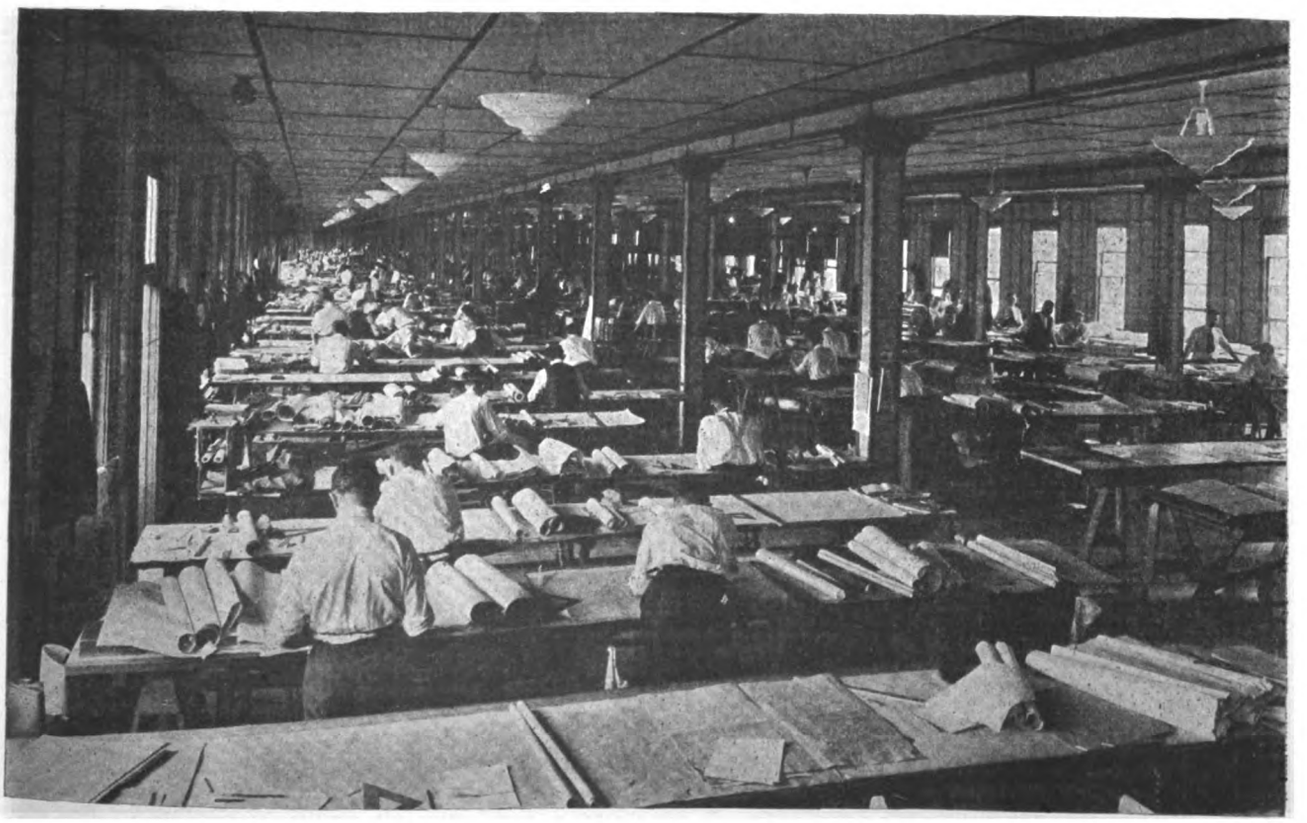

Fig. 1.—Looking Down the Long Drafting Room of the Technical Department, Bethlehem Shipbuilding Corporation, Ltd.

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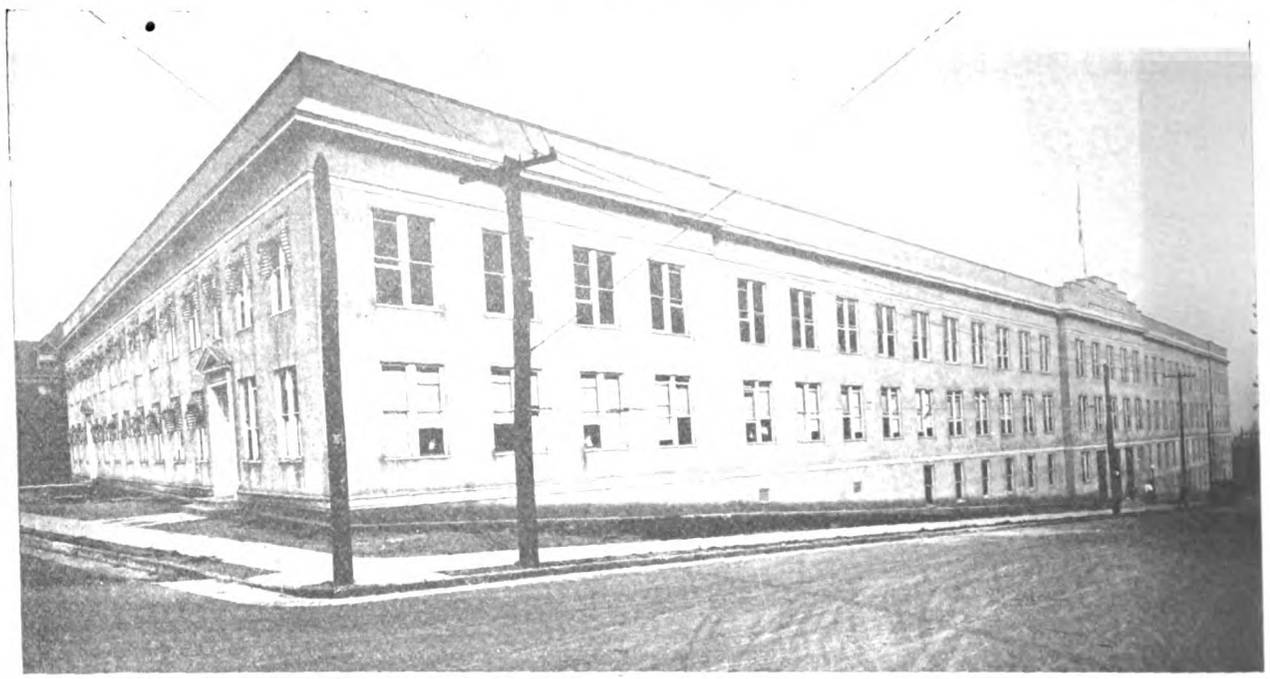

Fig. 2.—The Ship Engineering Building in Which the Drafting Room of the Bethlehem Shipbuilding Corporation is Located

minor changes on the process tracings at the yards. The same changes are made on the originals at the central office for record. The process tracings, made by a special process on tracing cloth, can be erased and changed as readily as an ordinary tracing made in India ink. The company maintains its own process tracing department at Bethlehem and has found the use of these tracings very satisfactory.

PLAN OF THE DRAFTING ROOM

Except for the marine auxiliaries and electrical work, the drafting of the technical department is all done in one immense drafting room which occupies nearly the entire third floor of the ship engineering building illustrated. The arrangement of the offices of the technical department is shown in the plan view. The drafting room, which extends the full length of the building, 350 feet, accommodates 400 draftsmen comfortably. The room receives light from windows on all sides; consequently the light is well distributed over the whole room and artificial lighting is seldom necessary.

Plans for improvements and extensions at the yards are prepared at Bethlehem in the plant engineering department, which is in charge of the mechanical engineer, reporting to the manager's department. This department which makes up the principal designs for mechanical, structural, architectural and electrical work in connection with new plant extensions, is separate from the technical department, having its own drafting room and offices.

The building in which the engineering departments are housed is located in the residential section of Bethlehem across the street from the campus of Lehigh University. The situation provides plenty of fresh air with quiet and pleasant surroundings, although conveniently located to all railroad stations and within a block of the street car lines. Practically all employees residing in Bethlehem can walk to and from work.

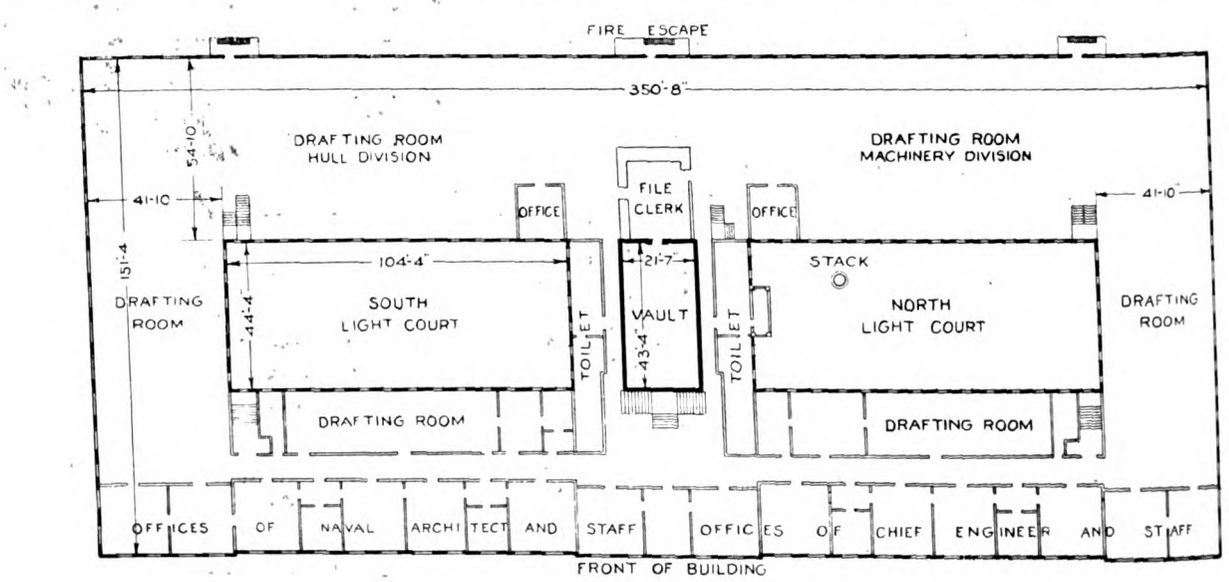

Fig. 3.—Arrangement of Drafting Room, Technical Department, Bethlehem Shipbuilding Corporation, Ltd.

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In order to encourage employees to fit themselves for better positions with the corporation, opportunity is given by the company for young men at the yards, who would be fitted for the work by inclination or by some previous knowledge of drawing, to come to the central office and work as designers or draftsmen. The wide variety of the work handled at the central office affords unusual diversity for the employee, and the company finds that a centralized system produces excellent results.

Our Former Enemy Ports

Kiel, Cuxhaven, Heligoland, as well as Hamburg up from the coast, all received their share of "place" in the German scheme of things when the Imperial Government calculated measures to spread her rule over the earth. These are ports and bases from which Germany intended to strike from off the high seas all allied shipping and fleets. Germany failed, and as places of stealthy hiding and lurking, Kiel and Heligoland are done.

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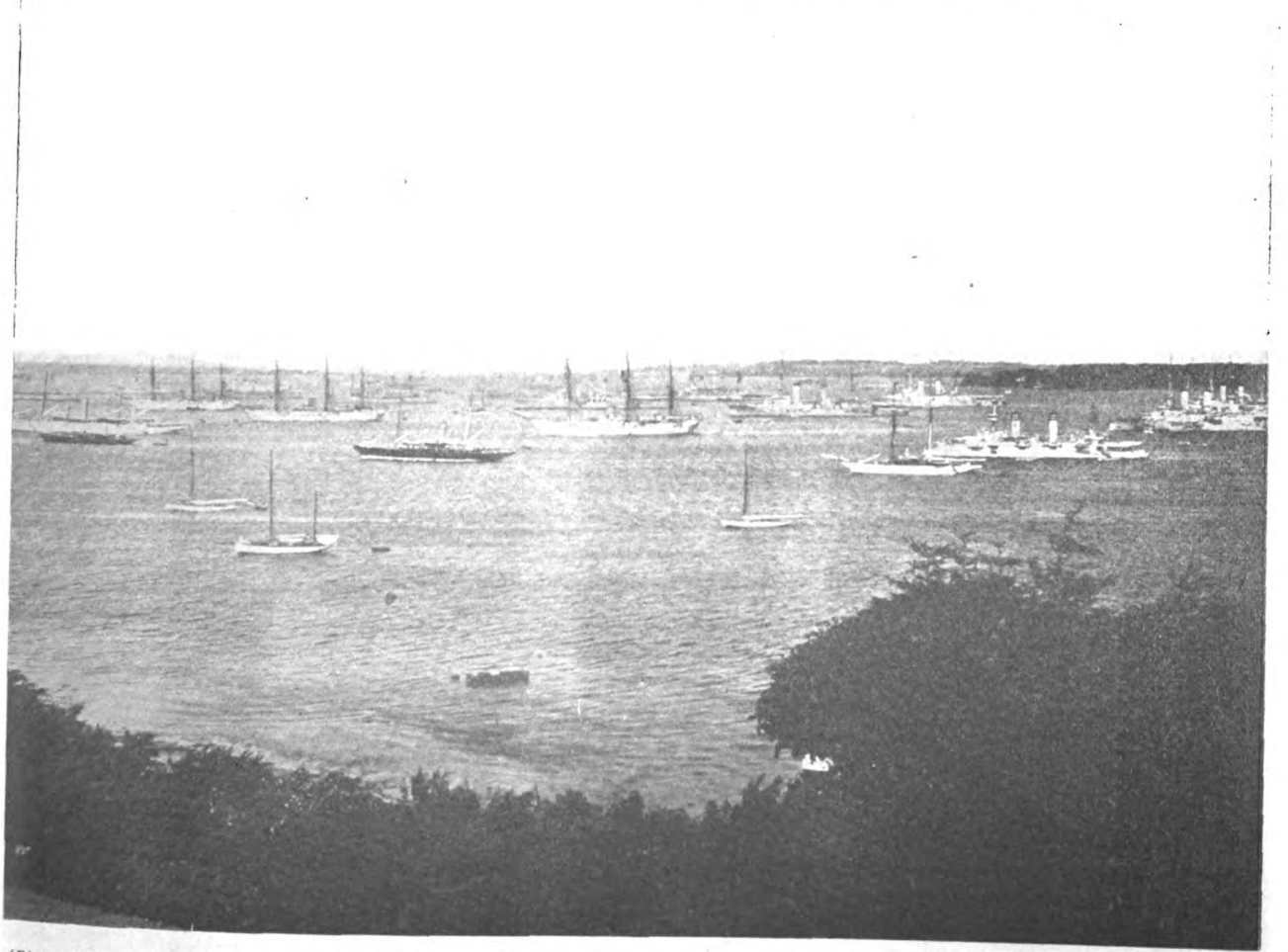
Heligoland



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Harbor of Kiel with the German Fleet Bottled In

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Delamater-Ericsson Memorial

THE American Society of Mechanical Engineers will hold a memorial meeting on December 3 at 8 P.M. in the Engineering Societies building, 29 West 39th street, New York, to commemorate the Phoenix Foundry, which was operated on West street between Vestry and Laight streets, New York, from 1838 to 1851, and the Delamater Iron Works, operated at the foot of West 13th street, from 1851 to 1889. Tablets will be erected on these sites. It was in these plants under Cornelius H. Delamater and Captain John Ericsson that great advances were made in naval architecture and marine engineering during this period. Anyone who has in his possession prints or documents relating to these works is requested to communicate with H. F. J. Porter, chairman, Delamater-Ericsson Memorial, American Society of Mechanical Engineers, 29 West 39th street, New York.

Competitive Tests of Electric and Geared Turbine Drive

WITH the building of five sixteen-hundred-ton, sixteen-knot coast guard cutters, two of which are to be fitted with electric drive and three with geared turbines, an opportunity will be given to secure exact data as to the relative merits of geared turbine and electric propulsion. Keels for these vessels have been laid at the Everett, Wash., plant of the Norway Pacific Construction and Dry Dock Company, and it is expected that the vessels will be completed within ten months. The hulls of the five vessels will be exactly alike. Oil-fired watertube boilers will be installed and the propelling machinery will develop 2,600 shaft horsepower giving the vessels a speed of sixteen knots with a cruising radius of 7000 miles.

Many years ago when the compound reciprocating marine engine was first proposed for ship propulsion the United States Coast Guard Service (at that time known as the Revenue Cutter Service) carried out similar comparative tests of the new and old type of propelling machinery in sister ships. The reports of these tests have been one of the most valuable classics in the field of marine engineering, both because of the ideal conditions under which the tests were made and because of the scientific manner in which the results were obtained. That the forthcoming tests of electric and geared turbine machinery will have the same, if not greater scientific value, goes without saying. These tests, however, will be of special value to shipowners because of the fact that the size of the propelling units to be installed in these vessels is practically the same as that of the average cargo steamship so that the results will have a direct application to merchant ships.

Recognition of the American Bureau of Shipping

SOME time ago a special committee representing shipowning, shipbuilding and allied interests was appointed by the Shipping Board to investigate the classification and rating of vessels. In the report of this committee, recently submitted to Congress, a number of highly important recommendations were made. First of all, the committee recommended that all technical questions concerning the construction of merchant vessels built or operated under the laws of the United States (in so far as such matters are regulated by statutes) should be submitted to the American Bureau of Shipping as the principal advisor to the executive branch of the Government under which supervision of such matters may rest. Incidentally, it is recommended that the American Bureau of Shipping be the regularly constituted authority for fixing load lines and freeboard, as provided in the Alexander bill now before Congress. Further than this, it is recommended that a joint committee with representatives from the proper Government authorities and the American Bureau of Shipping be established as the principal advisory authority to deal with all matters relating to the safe construction of ships and their machinery.

As compared with other maritime nations, the United States has been at a disadvantage on account of its lack of recognized authorities to pass officially upon such technical matters as outlined in the recommendations of this committee. Many difficulties and delays would be obviated if the authority of such committees as are designated in this report were recognized by the Government.

American Shipbuilder Surveys British Shipyards

HOLDEN A. EVANS, president of the Baltimore Dry Docks and Shipbuilding Company, Baltimore, Md., has just returned from Europe where he made a very complete industrial survey of the British shipyards. In his opinion the structural work on American vessels, barring possibly some vessels constructed under particular stress during the war period, is superior to the work in British yards. His visit to the Clyde shipyards revealed that these plants are uneconomically constructed for cheap shipbuilding and that England's present superiority as to cost of ship tonnage is due principally to the advantage of cheap labor which she enjoys although at present labor is growing much higher in England. Foreign shipping

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firms, he said, are still distrustful of American ships because of unfortunate propaganda now circulating in business circles. The Englishman, because his shipbuilding methods are different, has had a fundamental distrust of the American-built ship, and the loose propaganda in American newspapers regarding certain American firms has been applied to American shipbuilding at large.

As a result of his investigations Mr. Evans has declared that our shipyards are ahead of the English yards in compactness, efficiency and speed, due in many cases to modern equipment for handling materials and better planned yards. A detailed report of his findings will be submitted to the Shipping Board.

Programme of the Naval Architects Meeting

FOLLOWING is a list of the papers at the twenty-seventh general meeting of the Society of Naval Architects and Marine Engineers in New York on November 13 and 14:

THURSDAY, NOVEMBER 13

"Methods Employed in the Construction of Concrete Ships." By R. J. Wig.

"Engineering Features of Shipyards Operative During the War Period." By Captain R. E. Bakenhus, U. S. N.

"Steel Ship Construction from a Management Viewpoint." By Creighton Churchill.

"An Analysis of the Isherwood System of Ship Construction." By John Flodin.

"Economical Cargo Ships." By A. J. C. Robertson.

"Non-Rolling Passenger Liners." By E. A. Sperry.

"Submarines in General—German Submarines in Particular." By Commander E. S. Land, U. S. N.

FRIDAY, NOVEMBER 14

"Propulsive Efficiency of Single Screw Cargo Ships." By Commander William McEntee, U. S. N.

"Buoyancy and Stability of Troop Transports." By Professor William Hovgaard.

"The Application of Standardization and Graphical Methods to the Design of Cylindrical Boilers." By H. C. E. Meyer.

"New Developments in High Vacuum Apparatus." By G. L. Kothny.

"The Launching of Large Vessels in Restricted Waters." By Captain H. M. Gleason, U. S. N., and Lieutenant Commander H. E. Saunders, U. S. N.

"The Propelling Machinery of the U. S. S. *Leviathan.*" By E. H. B. Anderson.

"Standard Oiling System for Geared Turbines." By J. E. Schmeltzer and B. G. Fernald.

"Electric Propulsion on Merchant Ships." By W. L. R. Emmet.

The meeting will be held in the Engineering Societies building, 29 West 39th street, beginning at 10 A. M. each day of the meeting. The Council of the Society will meet in the Council Room on Wednesday afternoon, November 12, and the annual banquet will be held in the Grand Ball Room of the Waldorf-Astoria Hotel on Saturday evening, November 15 at seven o'clock.

American Fuel Stations

DURING the early stages of the war, Great Britain put into effect a system of bunker license as a necessary military measure. The United States Shipping Board realized that after-war conditions might develop a situation with respect to coal supplies which would dictate the necessity of a modified application of bunker license at British stations. In that event American shipowners would have been at a serious disadvantage unless immediate steps were taken to assure unrestricted operation of their ships in the world's trade. To accomplish this it was necessary to have oil burning steamships, instead of coal burners, and vessels with a steaming radius of at least 10,000 miles when practicable. The British order of September 29, 1919, justified these apprehensions.

It therefore became necessary for the Shipping Board to find suitable places for the establishment of fuel stations along the trade lanes or adjacent to them. At the Panama Canal facilities already existed and only required to be amplified. To take care of the east coast trade of South America, a station was erected at St. Thomas. This station, which had an initial capacity of 15,000 tons of storage, was opened on October 2. Arrangements have been made for establishing a station at the Azores and another at Bizerta, a small French island off Tunis and located on the ocean highway to the Indies. Material has also been assembled at Manila, where another large storage tank is to be erected.

"Despite what has been done," said J. H. Rosseter, director of the Shipping Board's division of operations, "we feel that we are still at the threshold of the major part of the question, which involves an increase in storage capacity of fuel stations and additional tank steamships for transporting oil to them. We must also take into account the fact that we must now carry oil to our Atlantic seaports, not only from Mexico but from the Texas and Louisiana fields as well. Finally we must awake to the importance of encouraging the establishment of national interest in other known and probable oil regions of the world."

Today the United States possesses a fleet of 486 oil burning steel steamships representing 3,798,733 deadweight tons of new construction. In addition there are 49 freighters of the oil burning type which have been reconveyed by the Shipping Board to their American owners and still another group of 18 which have been sold by the Board and which are under the American flag. Of the 720 steel vessels under construction and contracted for, 636 are oil burners, these aggregating 4,691,659 deadweight tons. When the steel programme has been completed there will be a total of 1,731 vessels of the oil burning type under the American flag.

The total requirements for oil for the United States merchant marine in 1919 have been estimated at 31,000,000 barrels and for the navy and merchant vessels for 1920 at 64,000,000 barrels. The importance of establishing a girdle of oil fueling stations around the world for American ships is therefore obvious.

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

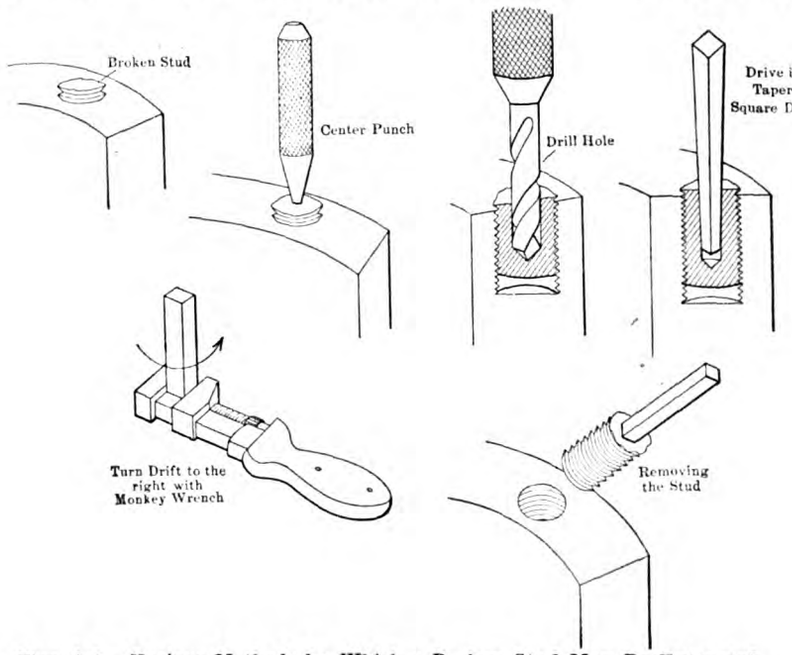
Removing a Broken Stud

This is a task that is frequently met with, and to old-timers the trick of taking out a broken stud is well known; but today there is reason to believe that a lot of the new young engineers that have come aboard our new merchant ships need to be shown some of the kinks and tricks of the trade. These simple sketches are drawn and described in an elementary fashion for the purpose of clearly conveying the manner in which most all broken studs can be extracted.

When the stud breaks off close to the part of the casting, so that it is not possible to apply a stillson on it, as shown in Fig. 1, take a center punch and center the stud, as shown in Fig. 2. Next select a drill that is about three-sixteenths smaller than the diameter of the stud and use it to drill out the center of the stud, as shown in Fig. 3, but be sure that you do drill in the center of the stud and that your drill is square with the length of the stud, for if you run off to one side the drill will cut out the threads in the stud hole, thus ruining it. When the hole is drilled, procure a square or any suitable three-cornered taper drift and drive it into the hole in the stud, as indicated in Fig. 4. Then apply a monkey wrench close to the stud on this drift, as shown in Fig. 5, turning to the right, for most all studs are right-hand threaded. The stud will come out on the drift as pictured in the last sketch, leaving the hole threads all right to receive the new stud.

Sometimes when the stud is so small that using a drift is out of question, the stud can be drilled so that nothing but the thin shells of threads are left in the hole and these picked out with a sharp-pointed, small tool. If the stud is of brass, a tap run in carefully will cut out the threads. A very suitable drift for even very small studs or broken screws can be made by grinding the tang of a file.

C. H. Willey.

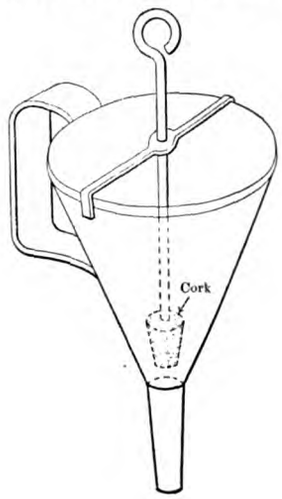


Figs. 1-6.—Various Methods by Which a Broken Stud May Be Extracted

Funnel Stopper

The simple little home-made kink shown in the sketch has been the means of saving considerable oil in the filling of containers. It always has been the habit of those who fill jugs and cans, etc., with the aid of a funnel, to stop pouring the liquid only when the funnel starts to fill up, then hastily removing the funnel and trying to put their fingers over the spout to save the liquid from spilling.

By taking a small length of ⅛-inch round rod, threading it at one end and screwing on this a cork stopper, then making a small bracket to fit across the funnel top, as shown, a means is provided to prevent spilling and waste. When the container is overfilled, the cork is shoved in the spout and then the funnel lifted and emptied. C.



Simple Device for Stopping the Flow of Oil Through a Funnel

Useful Kinks

While talking with an old engineer recently, he pointed out the height of water in a gage glass of a tank some distance away. The water level showed distinctly but was reddish in color. I remarked on this and he replied that he had found difficulty in reading the glass from a distance. He remedied this trouble by painting a strip of red lead about ¼-inch wide the length of the glass on the

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side away from the observer. It was surprising how effective this was in showing the water level at a distance.

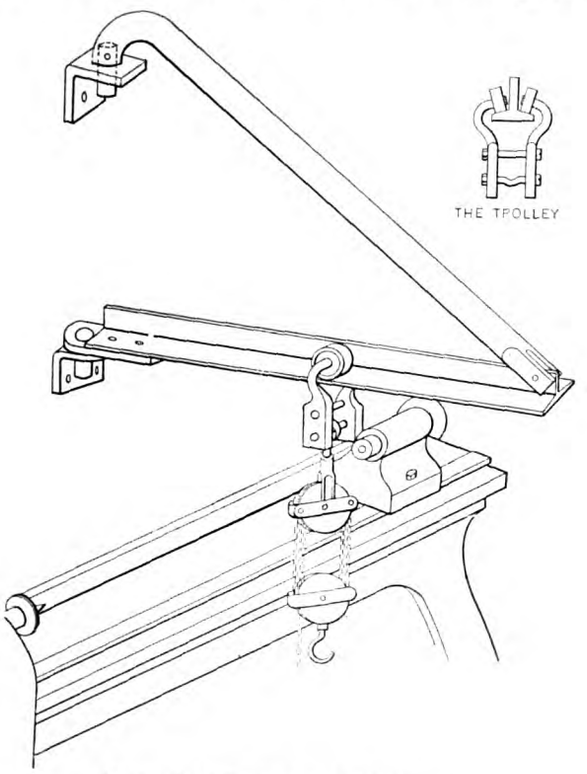
An interesting wrinkle in connection with boiling out express boilers was recently adopted by one of our shipyards. The boilers were boiled under one burner, maintaining a low pressure. Then, to aid circulation, the suction end of the auxiliary feed pumps was connected to the bottom blows of the boiler, while the discharge end of the pump was connected to the auxiliary feed valve on the steam drum. This insured proper circulation by pumping the water out of the water drums and back through the steam drums.

ENGINEER.

Lathe Swinging Track Crane

This contrivance was built by the ship's blacksmith and the shop men. It is not an elaborate thing, but a rough, home-made one, and yet it seems worthy of describing to other men who may need to improvise a good share of their shop appliances, especially on cargo carriers.

There had always been a need for a small crane that would handle the work that was done in the engine lathe



Convenient Crane for Lathe Work

that was too heavy for the machinist to lift alone; so one day the blacksmith came into the shop to get the shop machinist to do a job for his benefit, and the machinist said, "Sure, we'll swap. I want you to give me a hand to make a small crane for this place, and I'll help you on your work."

The result of their efforts was a simple affair that was both light, strong and handy, as the sketches will show. It consisted of two angle iron brackets, or pedestals, that were drilled for the crane pivot bearings and riveted to the steel bulkhead, a track and vertical arm of 3-inch tee iron, one end of which was riveted to a piece of steel plate that held the pivot piece and the other end of which was secured in the split, and flattened end of a piece of boiler tube 2 inches in diameter. The upper end of this boiler tube was bent at a 45-degree angle and had a short piece of round stock secured into it that set the hole of the pedestal angle plate that was riveted to the bulkhead. A trolley hanger with two wheels was easily made and used on the track, as shown, to hold the tackle for light falls.

This swinging crane was very easy to take down out of the way if necessary, but the idea of making it so that it could be slipped out of its pedestal brackets was so that it could be used in a corresponding set that were riveted to the bulkhead near the ship's small planer or shaper.

MACHINIST'S MATE.

Stud Re-Threading Kink

Occasionally, during making repairs or overhauling machinery, the threads of the studs get burred or bruised, or perhaps they need re-threading to make the nuts go on easier. To do this work without taking out the stud calls

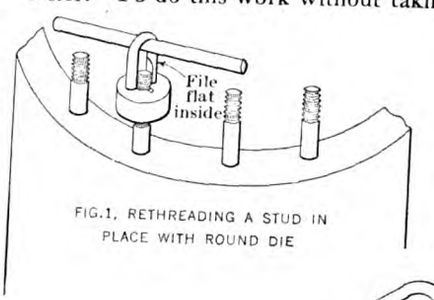


FIG.1, RETHREADING A STUD IN PLACE WITH ROUND DIE

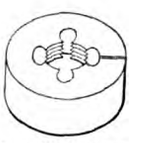


FIG.2, ROUND DIE

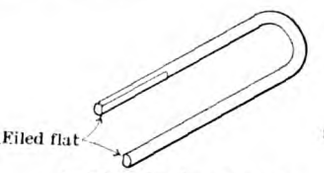


FIG.3 PIECE OF ROD BENT U-SHAPE

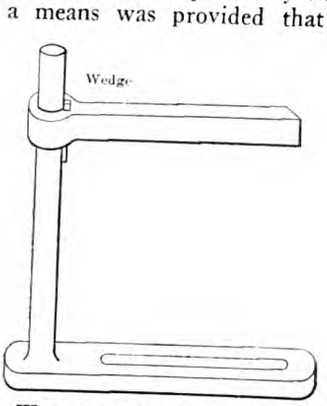
A Time-Saving Device

for use of a nut die. It so happened that the writer's plant had only round dies of the type shown in Fig. 2, and to use these an improvised holder was necessary. By making a long U-iron, the work was easily done, as shown in the sketch.

HELPER.

Wedged Arm Old Man

By a change of design in the arm hole of the old man drill post, that of cutting a tapered key way and fitting a wedge key, a means was provided that permitted the



A Tapered Key Way and a Wedge Key Hold the Arm of the Old Man at Any Desired Height

ready adjustment of height of this arm without the necessity of a wrench.

To release the arm, the wedge is tapped up, thus loosening it, and again secured by tapping it in place. The old manner of securing the arm on the post with set screws was quite bothersome, as it required a wrench.

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often broke off the set screws and marred the post with the point of the set screw. D. P.

Removing Stiff Gage Frames

The usual procedure on the part of the average engine room mechanic when he meets with a gage frame that is frozen on is to take a wrench and, applying it to the rim, try to start it off. This usually dents or mutilates the rim

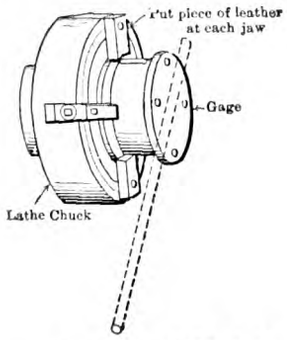


Fig. 1.—Usual Method

and distorts it so that it will not come off, also ruining its appearance. There are two real sensible ways to deal with such stubborn gage frames which are illustrated in the sketches.

One is by putting the whole gage in the lathe chuck and setting up each jaw, placing a piece of leather under

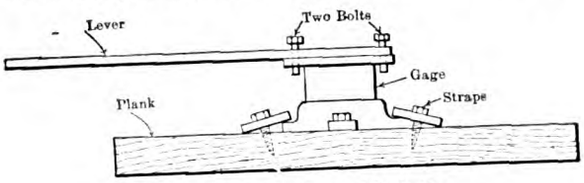


Fig. 2.—Emergency Method

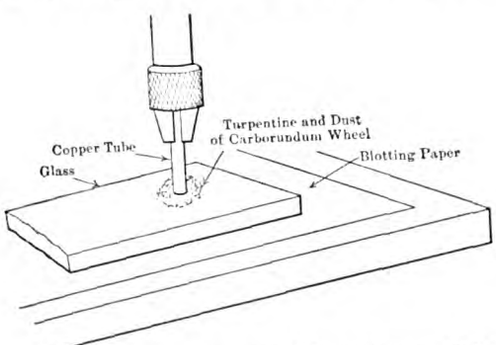
each jaw to protect the rim. By putting in a couple of pins in the bolt holes of the back of the gage and using a lever, the body can be then easily unscrewed.

When no lathe chucks are at hand, the method of fastening the gage frame down to a piece of plank with four straps and small lag screws, shown in Fig. 2, is used.

THE CHIEF.

Drilling a Hole in Glass

The accompanying sketch shows a unique method of drilling a hole in glass by aid of a copper tube, carborun-



Glass Plate Being Perforated by a Copper Tube

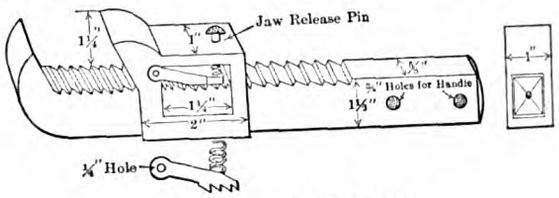
dum dust and turpentine. If a steady, even pressure is applied by the drill press, special care being taken when going through the glass, a clean, even hole can be obtained. The sheet of glass should be laid on a pad of blotting paper to obtain the best results.

Concord, N. H. CHAS. H. WILLEY.

Handy Wrench for the Tool Kit

The wrench illustrated in the accompanying sketch is quite easily made and has certain advantages of strength and adjustability over the ordinary type of monkey wrench.

It is of a particularly heavy design, but may be made much lighter if required. The shank and jaws are of case-hardened machine steel, while the sliding jaw holder



Quick Adjustable Wrench

is of ordinary hardened tool steel. Special care should be taken that the angle of the jaws is similar to that of an S-wrench, which is about 15 degrees. Either a wooden, pipe or extension handle may be fitted to the shank.

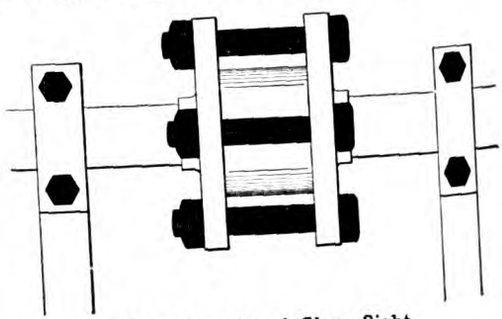
Stillwater, Minn. OTTO DORTHEN.

Sight Glass on Discharge Side of Trap

We had been bothered with feed oil leaking into the feed tank, but could not locate the source of trouble very easily because of the radiator coils, heaters and steam line used for atomizing the galley oil blocking the fuel oil suctions.

To be able to locate the trouble easily and quickly at all times, pet cocks were placed in the drains at each of the five drain traps. However, this did not help matters any, as the attendants were careless and paid little attention to them.

The problem was finally solved by putting a sight glass on each of the drains close to the trap. The attachment is



Arrangement of Glass Sight

nothing more than two 5-inch flanges ½-inch thick, held together by four ½-inch bolts passing through 9/16-inch holes. These flanges are counterbored ¼-inch to receive the rubber gasket and the glass. The glasses are 2 inches long, 2¾ inches in diameter, ¼ inch thick. As the traps are of low pressure, no trouble has been experienced with the glasses leaking or breaking. Brackets support the drain pipe on each side of the glass. Alongside each glass there is placed a nipple of the same size and length as the glass, so that in case of breakage this can be inserted into the tube temporarily. Glasses can be easily removed when it is necessary to clean them, and show at all times whether the trap is functioning properly or not.

JOGOKO.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Piping Systems in Merchant and Naval Practice

Q. (1020).—Please give material of the principal piping systems aboard ships both for merchant and naval practice.

A. (1020).—Below is a list which represents average American practice. There are, however, installations which differ from this list:

	Merchant	*Naval*
Steam Lines		
Main steam.....	Wrought steel or copper	Seamless steel
Auxiliary steam...	Wrought steel	Seamless steel where over 2 inches, copper otherwise
Deck steam.....	Wrought steel or copper	
Exhaust Lines		
Main exhaust.....	Riveted steel	Riveted steel
Auxiliary exhaust.	Wrought steel	Seamless copper
Deck exhaust.....	Wrought steel	
Main escape.....	Copper	Sheet steel riveted
Steam Heating.....	Black wrought steel	
Fresh Water Piping		
Boiler feed.....	Copper	Seamless copper
Evaporator, salt water feed.....	Galvanized wrought steel	Galvanized wrought steel
Drinking and distiller	Galvanized wrought steel	Copper or galvanized wrought steel
Sanitary	Galvanized wrought steel	
Salt Water		
Sanitary service...	Galvanized wrought steel	
Main engine cooling water to bearings	Brass	
Refrigeration		
Ammonia and brine*	Black wrought steel (extra heavy)	
Carbon dioxide...	Black wrought steel	
Fuel Oil†	Extra heavy wrought steel	Seamless steel

* Cannot use brass or copper.
† Cannot use copper.

Bilge and ballast piping in the merchant service may be of galvanized wrought steel, cast iron or lead. Cast iron piping with lead expansion bends is often used. Lead piping is used to connect pump manifolds in the engine room, and same should be thick enough to stand the vibration which is sure to occur here. Sounding and air pipes are, of course, of galvanized wrought steel.

REFERENCE.—"Care and Operation of Naval Machinery," Commander H. C. Dinger, U. S. N.

The Seven Seas

Q. (1021).—What are the seven seas, where did the expression originate, and what is your authority for the same?

A. (1021).—The seven seas are the Arctic, the Antarctic, the North and South Atlantic, the North and South Pacific and the Indian oceans. As to where the expression originated, it is not easy to state. In all probability, since the number seven symbolizes completeness or perfection, it was felt that the creation of the world demanded that number for its completion. Thus the rabbis as early as the beginning of the Christian era affirmed that "God made the seven seas, but the sea of Galilee is His delight." In modern times the phrase is employed both by Fitzgerald (in "Omar Khayyam") and by Kipling. One version of Omar Khayyam (1872), in stanza XLVII, reads: "Which of our coming and departure heeds as the Seven Seas should heed a pebble cast." Kigling (1896) published a book of poems entitled "The Seven Seas." Like not a few other phrases which have come down to us, the parentage is difficult or impossible to trace.

Operating Cost—5,000-Ton Deadweight Steamer

Q. (1025).—Kindly inform me the operating expenses of an American 5,000-ton deadweight steamer.

A. (1025).—Your question might be taken in several ways, due to the meaning of the word "operation" and also the fact that the voyage is not specified. It may be of interest to know that the terms operating and managing are synonymous.

The manager is expected to have charge of all repairs, to see that vessel and equipment are kept in an efficient state, to furnish and pay crew and to store vessel.

The operator must furnish cargo or charter, pay for bunkers, fresh water, also port charges, such as tow-boat hire, consular and agency fees and stevedoring. In fact, the operator has to pay all charges which would be borne by a time charterer.

The operating and managing expenses vary so greatly with length of voyage that it is very hard to give a definite rule. The ratio of loading cost and repairs to total operating and managing cost will decrease with increased length of voyage. In one example known to the writer, in which a vessel was at sea only 45 percent of the total time, the cost for wages and provisions for crew was equal to the cost of fuel, repairs and stores (deck and engine).

The cost of repairs, fuel, crew's wages and food will run into the neighborhood of $450 (93/15/0) per day for this size steamer. It is customary to allow about 15 percent of ship's cost per annum for insurance, depreciation and repairs; split about equally among those three charges.

The figures below give the approximate percentage for some of the different operating charges:

	*	†
Vessels' time steaming total length of voyage (including loading and discharging).....	.53	.62
	Percent	Percent
1. Repairs, insurance and depreciation.....	17	16
2. Boiler and engine room supplies and fuel.	19	32
3. Wages and provisions.....	11	10
4. Harbor dues	32	33
5. Loading charges	15	5
6. Brokerage and office fees.....	6	4

* This vessel's voyage about one-half that of † in length.

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Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items

MANY TANKER CONTRACTS PLACED DURING THE MONTH

A. G, W. I. Order Eight Vessels —Other Companies Asking Bids

The Shipping Board statement that the tanker shortage for the coming year would be at least 1,000,000 tons is verified by the number of private ship contracts for tanker tonnage which have been placed during the last month. The largest contract was placed by the Atlantic Gulf and West Indies Steamship Lines, 11 Broadway, New York. Two of these vessels, of 10,600 tons each, will be built by the Sun Shipbuilding Company, Chester, Pa. The Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., holds an order for four of the tankers of 12,600 tons each, and the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., an order for two tankers of 14,800 tons each.

The National Oil Company, Woolworth building, New York, has just launched a 6,000-ton oil tanker at the company's yard in Orange, Tex. A second tanker of similar tonnage and design, equipped with Diesel engines, is also being built for the company's own account.

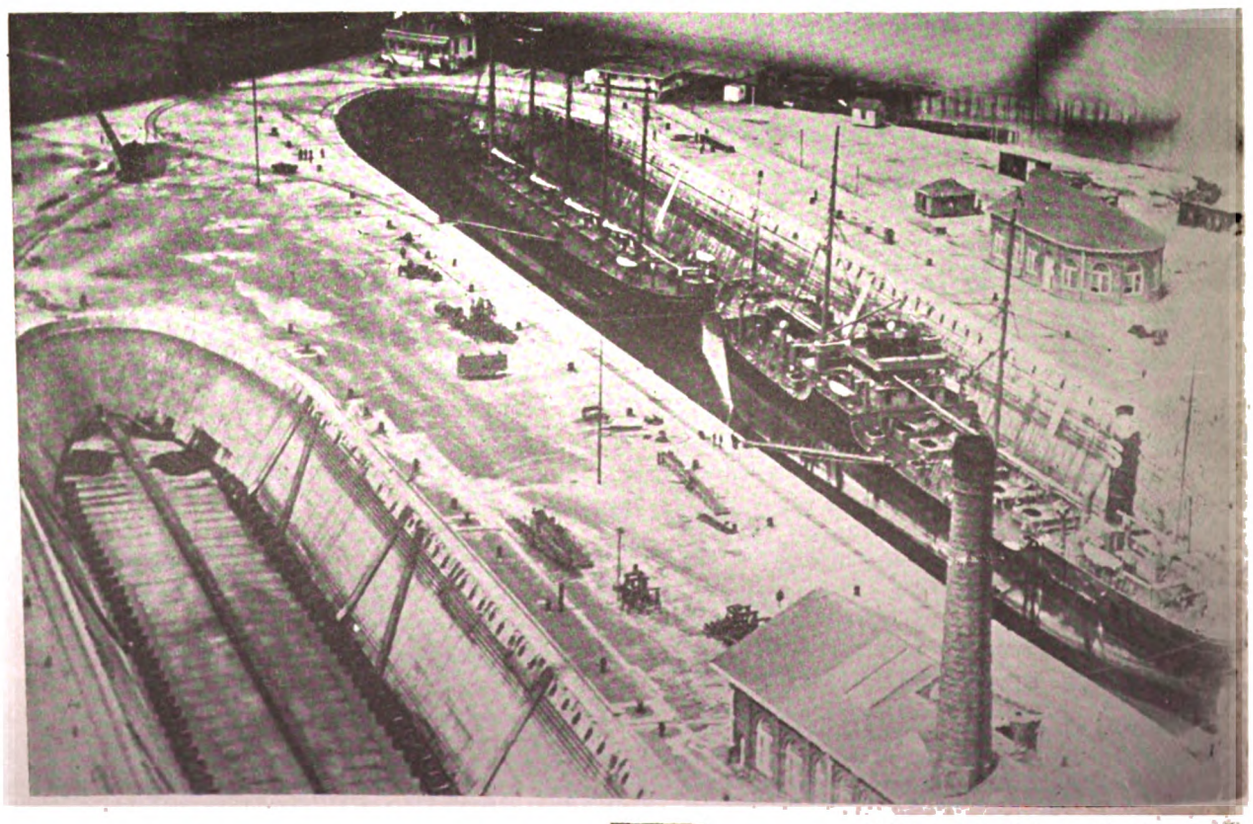
In addition to the contract for three tankers which has been placed with the Bethlehem Shipbuilding Corporation, Ltd., the Pan-American Petroleum and Transport Company, Los Angeles, Calif., and 120 Broadway, New York, is in the market for three more oil tankers. The Vacuum Oil Company, 61 Broadway, New York, which has also recently placed an order for one tanker with the Bethlehem Shipbuilding Corporation, Ltd., is in the market for two oil tankers, and the Cities Service Company, 60 Wall Street, New York, is now negotiating with several shipyards for the construction of two tankers. The Sinclair Consolidated Oil Corporation, 120 Broadway, New York, which has recently placed two new tankers in service, is also in the market for additional tankers at favorable prices.

The rumor that the Texas Oil Company, 17 Battery Place, New York, has purchased six tankers, as recently published, is denied by the company. The statement was probably based on the fact that the company was asking prices on tanker tonnage.

PRIVATE CONTRACTS AND REINSTATEMENTS EXCEED 348,400 TONS

Further Navy Contracts Placed

Many contracts for special tonnage are now being placed by private companies. The Crowell & Thurlow Steamship Company, 131 State street, Boston, Mass., has placed a contract for a 9,600-ton steamship with the Bath Iron Works, Bath, Me. John S. Emery & Company, 114 State street, Boston, Mass., is still negotiating for the purchase of ten 10,000-ton vessels, which are now partly completed in a California yard. The Bethlehem Steel Company, South Bethlehem, Pa., plans to build in its own yards fifteen large steamships to carry oil to South America and handle ore on the return voyage. The Shawmut Steamship Company, 60 Federal street, Boston, Mass., has placed an order for two 10,500-ton freighters with the Chester yard of the Merchant Shipbuilding Corporation, Chester, Pa. The Newburgh Shipyards, Inc., Newburgh, N. Y., will build two 7,500-ton vessels for the Union Sulphur Company.



(Photograph by Underwood & Underwood, N. Y.

View of the Two Graving Docks Now Operated by the Bethlehem Shipbuilding Corporation at Hunter's Point, Cal. The Larger Dock is 1,096 Feet Long, Including Caisson; Only a Portion of the 730-Foot Dock is Shown in the Photograph

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On Government contracts several reinstatements have been announced. The Groton Iron Works, Groton, Conn., has received a reinstatement on six 8,800-ton steel vessels from the Shipping Board. The Southwestern Shipbuilding Company, San Pedro, Calif., according to a statement reported to have been issued by Marco H. Hellman, president of the Company, has secured a contract involving $20,000,000 from the Emergency Fleet Corporation. These vessels it is reported, ten in all, will be operated between the Pacific coast ports and Boston.

On navy work, the Norway Pacific Construction and Dry Dock Company, Everett, Wash., is about ready to close a contract for several vessels. This work is in addition to the contract for five 1,600-ton revenue cutters already received. The Fore River yard of the Bethlehem Shipbuilding Corporation, has received a contract for six type *S* submarines through the Electric Boat Company, 11 Pine street, New York. The American International Shipbuilding Corporation, Hog Island, Pa., has received orders to finish twelve 8,000-ton vessels on contract No. 83 as transport ships.

Prospective Ship Contracts

In addition to the outstanding bids for tanker tonnage, reports show that many private companies are about ready to place contracts for other special ship construction. N. E. McClelland, a naval architect, located at 2 Stone street, New York, is in the market for twenty 165-foot steel three-masted schooners of 850 to 900 deadweight tons each. Theodore E. Ferris, naval architect, 30 Church street, New York, is preparing plans and specifications for two freight steamers to be built for the Eastern Steamship Lines. He is also working on plans for converting seven vessels of these lines into oil burners. Two 415-foot fruit vessels with a speed of 17 knots are being designed by William Gardner, 1 Broadway, New York.

On the West coast, a man by the name of Moore, located in Seattle, Wash., has organized a company to build a fleet of twenty freighters of 10,000 tons each. The Pacific Mail Steamship Company, 508 California street, San Francisco, Calif., proposes to place four new trans-Pacific liners in service.

Lord & Curtis, 32 Regent street, London, according to a cable from the American Attache at London, are in the market for ten 6,000-ton cargo steamers and three passenger steamers from 2,000 to 3,000 tons.

Capacity of Hunter's Point Drydock

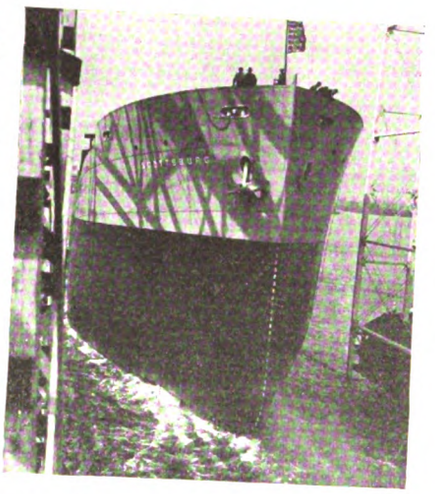
Joseph J. Tynan, general manager of the Bethlehem Shipbuilding Corporation, Ltd., Union Plant, San Francisco, Cal., has announced that the new concrete drydock at Hunter's Point, San Francisco, Cal., is large enough to handle any of the six cruisers it is proposed to dispatch to Pacific waters upon completion. The length of the dock, clear of caisson, is 1,000 feet, and the breadth on coping 153 feet. The depth on sides is 48½ feet and the bottom breadth is 110 feet.

Two Large Ore Carriers and Ten Ocean Vessels to Be Built on the Great Lakes

The American Ship Building Company, Cleveland, Ohio, it is understood, has received orders for two large ore carriers and ten vessels of the Welland Canal size, which will be used in the Atlantic Ocean service.

New Pattern Shop for Norfolk

The Bureau of Yards and Docks, Navy Department, Washington, D. C., is planning the construction of a pattern shop at the Norfolk Navy Yard.



Launching the 436-Foot Freighter Scottsburg at the Yard of the New York Shipbuilding Corporation, Camden, New Jersey

Allotment of Pacific Fleet

The Government Navy Yard at Bremerton, Wash., has been designated as the home yard for eighty-four vessels of the Pacific fleet, including all vessels of the super-dreadnaught type. This does not assure, however, that all repair work, overhauling and supplying for this vast fleet will be handled through the Bremerton yards. Mare Island Navy Yard will serve as the home yard for forty-eight ships of the second line, also smaller craft.

The Cleveland Crane & Engineering Company, Wickcliffe, Ohio, has received a contract to install wall cranes in the Mare Island structural shop. About $103,000 is involved in the work. Manning, Maxwell & Moore, 119 West Fortieth street, New York, have received a contract for similar work which will cost $94,876.

Fluctuation in Sale Price of Sailing Vessels

The Standard Oil Company has recently sold two large sailing vessels to the Robert Dollar Company for $520,000. Several years ago one of the vessels, the *Dunsyre*, was purchased for $18,000. During the war period it was sold for $140,000, and later to the Standard Oil Company for $250,000. Both vessels are steel and were built about twenty-eight years ago at Glasgow, Scotland.

ENGLISH SHIPYARDS HOLD CONTRACTS FOR FIVE AUSTRALIAN VESSELS

Australian Shipbuilding Programme

William Beardmore & Company, Dalmuir-on-the-Clyde, has received a contract from the Australian Government for two cargo steamers of 22,500 tons each. The vessels will be 530 feet between perpendiculars, 68-foot beam and 43 feet 6 inches molded depth. Three vessels of a similar size are to be built by Vickers, Ltd., Barrow-in-Furness. Report has also been received that six 12,000-ton vessels will be built in Australia for the Government.

Vessels of 5,000 and 6,000 tons are now under construction at West Point and Cockatoo Island for Government service. Although Australian Government shipbuilding has up to the present time proved profitable, English steamship operators feel that the situation will remain so only temporarily.

The Canadian Government Shipbuilding Programme

The Canadian Government shipbuilding programme calls for vessels of three types—one, two and three deckers—and in seven sizes. Two are to be 2,800 tons each, four 3,400, five 3,750, eight 4,300, eight 5,100, sixteen 8,100 and two 10,500.

The ships are being constructed in Halifax, New Glasgow, Levis, Three Rivers, Montreal, Kingston, Welland, Collingwood, Port Arthur, Prince Rupert, Vancouver and Victoria. The total deadweight will be about 256,000 tons. The total cost will be $52,000,000. The service will be operated by the Canadian National Railways.

Report on Japanese Shipbuilding Estimates $187 as Cost Per Ton

A report forwarded from Tokio states that 3,000 men have been laid off at the Osaka Dock Yard. At the meeting of the directors the president explained that a recent loss of 3,620,000 yen had been sustained. The Kawasaki Dock Yard still retains contracts for three cruisers and two destroyers for the Japanese navy, five steamers for United States interests, and thirty vessels from 6,800 to 9,100 tons. At present it costs $187 per ton for steel cargo carriers built in Japan, and S. Hirota, manager of a Japanese steamship company, reports that the continual increase in cost may force Japanese interests to construct vessels in this country where steel may be obtained more cheaply.

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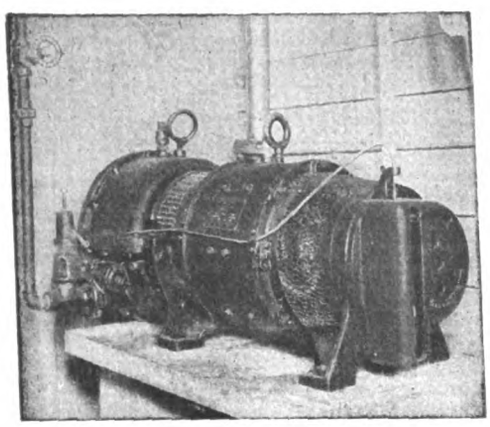
Compact Electric Turbo-Generator

A compact electric lighting turbo-generator, which is especially adapted for use on tugboats and small harbor and river craft, has been placed on the market by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

This generator has a capacity of 7½ kilowatts, generates direct current at 250 volts, and has sufficient power to provide current for fourteen incandescent lamps and a searchlight.



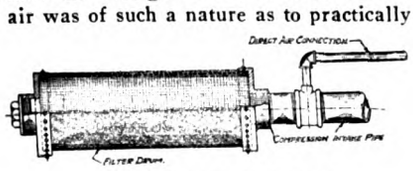
Westinghouse Turbo-Generator

In a recent installation on a United States Government tugboat an impulse-type steam turbine and an electric generator were combined to form this single compact unit. The plant will take steam at from 70 to 225 pounds' pressure directly from the boiler without a reducing valve. The exhaust steam, if it is operated non-condensing, is free from oil and can be used for heating purposes. The speed is 4,000 revolutions per minute; the use of an automatic governor prevents over-speeding.

Practical Cloth Air Filter

One of the simplest means to prolong the life of tools, as well as the compressing equipment, is proper cleansing of the air supply at the compressor intake.

A study of the pneumatic tool situation at one of the large shipyards showed that the foreign matter carried in the air was of such a nature as to practically preclude the use of the small wire gauze strainers. The operators arbitrarily remove the strainers on account of the delays which they cause.



Practical Cloth Filter

Cloth filter screens, if properly designed, will clean the air to a very large extent. The larger the filtering area the closer the grade of cloth that can be used, and the more perfect the filtration.

Tests made by the standard practice branch of the Emergency Fleet Corporation show that air will pass through a light grade of unbleached muslin at the rate of 100 cubic feet per minute per square foot of area, when subjected to a suction pressure of approximately 1/100 of a pound.

It is possible to extend the suction pipe outside of the building in the form of a drum, constructed of heavy wire netting, as indicated by the accompanying sketch. The filter cloth can be placed around the drum.

If a supporting layer of poultry wire is secured around the outside of the cloth, cleaning can be conveniently accomplished by admitting a volume of high-pressure air directly into the intake pipe, and reversing the flow through the cloth at intervals when the compressor is not in operation.

A Small Electric Light Plant Equipment

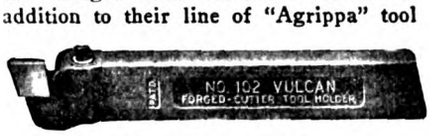
An outgrowth of the small turbo-generator sets installed in locomotives for headlight service is embodied in the new Buda-Ross electric light plant equipment made by The Buda Company, Railway Exchange building, Chicago, Ill. The unit is intended for small industrial plants using boilers, for steamboats, dredges, steam shovels, and for similar lighting purposes where the requirements do not exceed 1 kilowatt.

The outstanding feature of this type of lighting plant is the unusually small size for a steam turbo-generator plant (the two sizes available are of ½ kilowatt and 1 kilowatt capacity).

Special automatic governors control the speed, while the field coils of the generator have compound winding, which keeps the voltage uniform over the lighting circuits. The operation is thus made entirely automatic except for the turning on of the steam when the lights are needed.

Forged Cutter Tool Holders

J. H. Williams & Company, Brooklyn, N. Y., have recently produced the "Vulcan" forged cutter tool holders as an addition to their line of "Agrippa" tool holders. It is claimed that this holder makes possible the use of what is practically a solid tool without its expense.



New Vulcan Tool

Each holder by the insertion of a small high-speed steel forged cutter is made suitable for service in any regular machining operation on the lathe, planer, cutter, etc. The holders are drop-forged from a fine grade of steel and heat-treated to develop maximum toughness and stiffness. They are simple in construction, being composed of three parts—the holder proper, a square-head cam and a locking pin. "Agrippa" drop-forged high speed steel cutters are available in a wide range of sizes and types—side tool, diamond point, roughing, hog nose, flat nose, threading, etc.

Special Cutter

Advantages of the Free Port of Copenhagen

American exporters have been advised by Roger Neilson, of the Danish legation, that goods may be stored in Copenhagen's storehouses free of rent for two weeks in the care of the Copenhagen Free Port Company, which is in a position to issue warehouse warrants upon which the merchants can raise loans at Copenhagen banks.

Vapor Proof Reflector Globe

By using the prismatic construction the Holophane Company, 340 Madison avenue, New York, has designed a combined vapor-proof globe and reflector. The reflecting prisms on the upper portion of the globe redirect the light downward; refracting and diffusing prisms on the lower surface distribute the light in different directions in the desired proportions. The company states that tests show that the illumination is increased 75 percent over that produced by the ordinary clear vapor-proof globe. These globes are made for 40 and 60-watt type B lamps and for 75, 100 and 150 watt type C lamps now in use in connection with the standard vapor-proof fittings, including the standard nave thread.

Vapor Proof Reflector Globe

Gear Cutting Exhibit

A novel exhibit of gear cutting was held recently on one of the principal streets of Cleveland by the Van Dorn & Dutton Company of that city.

The object of this demonstration of the use of machine tools and gear cutting was to give the public an idea of modern production methods in this connection and of the extent and application of the gear cutting industry. Special types of gearing for electric cranes, hoists, mill machinery, bevel, spiral rack and pinion, sprocket and the like were shown.

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Marine Construction News of the Month

Ships, Shipyards and Shipyard Improvements—Terminal Projects Launchings—Government Contracts

SHIP CONTRACTS

The American International Shipbuilding Corporation, Hog Island, Pa., has received orders from the War Department to finish twelve 8,000-ton deadweight vessels, keels for which have already been laid under contract No. 83, as transport ships. The vessels are standard type, 448 feet on the load waterline, 58 feet beam and 40 feet depth with an estimated speed of fifteen knots. Each vessel will be fitted with six watertube boilers and geared turbines of 6,000 shaft horsepower. It is expected that these vessels will be completed by May 1, 1920.

The Atlantic Gulf & West Indies Steamship Lines, 11 Broadway, New York, has placed contracts for eight oil tankers. Two of these, of 10,600 tons each, will be built by the Sun Shipbuilding Company, Chester, Pa. The Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., holds an order for four tankers of 12,600 tons each and the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., an order for two tankers of 14,800 tons each.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has received a contract to recondition the British steamship *Eurana* of the Green Star Line. The company has also received a contract to fit the motor tanker *Brammel Point* with Diesel engines. This vessel, of 4,990 deadweight tons, was launched at the company's yards in 1916, equipped with three Bolinder engines.

The Bath Iron Works, Bath, Me., has received a contract for one 9,600-ton steamship from the Crowell & Thurlow Steamship Company, 131 State Street, Boston, Mass.

The Cairo Wood Products Company, Cairo, Ill., which holds a contract to build 35 barges, five of which are 145 feet by 34 feet by 7 feet, and twenty-five 130 feet by 26 feet by 7 feet, is constructing this tonnage of long leaf yellow pine lumber and timbers. The barges contain seven transverse bulkheads and two longitudinal bulkheads and are fitted with pumps and piping, as well as electric wiring. The company also expects to begin building shortly eight large barges for handling stone and gravel.

The Cammell-Laird Company, Birkenhead, Eng., has received a contract from the French Ministry of Marine for the construction of a passenger and mail steamer for service between Marseilles and Northern Africa. The propelling machinery will be of the double reduction geared turbine type with cylindrical boilers for coal and oil burning.

The Clooney Construction & Towing Company, Westlake, La., has received a contract to build five barges for the Western River Service.

The Compagnie General Transatlantique, with New York offices at 19 State Street, has placed contracts for 300,000 tons of new ships, according to a statement issued by John Dal Piaz, managing director of the company. N. Claveille, minister of maritime transport, Paris, France, has announced, after careful examination of all the contracts, that French shipowners have already placed orders either in France or abroad for over 1,000,000 gross tons of shipping.

The Cubitt Shipbuilding and Dry Dock Company, Chiswick, England, has received an order for two concrete motor coasters.

The Donaldson Steamship Company, 17 Battery Place, New York, has ordered six steamers for the Atlantic trade. The Anchor-Donaldson Line, has ordered two vessels for the Glasgow and Montreal route. Seven of these vessels will be constructed in the Clyde yards; the other vessel will be built at Barrow-in-Furness.

The Electric Boat Company, 11 Pine Street, New York, has placed a contract with the Fore River Yard of the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., for six type *S* submarines. When this is completed 18 vessels of this type will have been constructed at Fort River.

William Beardmore & Company, Dalmuir-on-the-Clyde, has recently received a contract from the Australian Government for two cargo steamers of 22,500 tons each. The vessels will be 530 feet between perpendiculars, 68-foot beam and 43 feet 6 inches molded depth.

The Bethlehem Steel Company, South Bethlehem, Pa., plans to build in its own yards 15 large steamships for its own use to carry oil to South America and bring back ore.

John S. Emery & Company, 114 State street, Boston, Mass., is still negotiating for the purchase of ten 10,000-ton vessels which are partly completed in a California shipyard. The Shipping Board has made no announcement confirming the transaction.

The Groton Iron Works, Groton, Conn., has received a reinstatement on six 8,800-ton steel vessels on a previous contract received from the Shipping Board.

Harland & Wolff, Belfast, Ireland, has received a contract from the British & Irish Steam Packet Company, for two 300-foot passenger vessels, designed to make 16 knots.

Hodgdon Brothers, East Boothbay, Me., have received a contract to build an auxiliary schooner of about 85 feet at the water line for arctic exploration work by Professor Donald B. MacMillan of Bowdoin College. The vessel will cost about $20,000.

The B. P. Lanteri shipyards, Pittsburgh, Cal., have received a contract from the Monarch Dredging Company, Benecia, Cal., to build a concrete and wood dredger to cost about $125,000. The hull and deck of this craft will be of steel and concrete. The bottom will be made of wood.

The Larne Shipbuilding Company, Ltd., Antrim, England, according to a recent report, has received contracts for several steel screw cargo steamers of 600 tons each.

P. Jesse Matton, Watervliet, N. Y., has received a contract to build eight barges for New York parties. These boats will have a displacement of about 750 tons.

The National Oil Company, Woolworth building, New York, has just launched a 6,000-ton oil tanker at the company's yard in Orange, Texas. A second tanker of similar tonnage and design, equipped with Diesel engines is also being built for the company's own account.

The Newburgh Shipyards, Inc., Newburgh, New York, holds a contract for two vessels of 7,500 tons deadweight from the Union Sulphur Company, 17 Battery Place, New York. This publication announced the placing of the contract for one vessel last May. These vessels will be equipped with geared turbines driving twin screws, the shafts being led through patent bilge tunnels on the Simpson-Gordon principle. The ships, which will be 375 feet overall, will be equipped to burn oil.

The Norway-Pacific Construction and Drydock Company, Everett, Wash., is about ready to close a contract for several Government vessels. This work is in addition to the contract for five 1,600-ton revenue cutters already received. As soon as details are arranged regarding this construction, full information will be given out by M. G. Thomle, president of the company.

The Pan American Petroleum & Transport Company, Los Angeles, Calif., and 120 Broadway, N. Y., has placed a contract for three tankers with the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa.

The San Francisco Shipbuilding Company, Oakland, Cal., according to a statement issued by V. H. Poss, has received a cancellation on three concrete vessels.

The Shawmut Steamship Company, 60 Federal street, Boston, Mass., has placed an order for two 10,500-ton freighters with the Chester yard of The Merchant Shipbuilding Corporation, Chester, Pa.

PROSPECTIVE SHIP CONTRACTS

Extensive Ocean Tonnage, New York.—The American Ship & Commerce Company, the holding corporation of the Kerr Steamship Company, 17 Battery Place, New York, is about ready to close a contract for foreign ship tonnage. The company has $10,000,000 available for this purpose.

Four Ocean Steamers, San Francisco.—The Pacific Mail Steamship Company, 508 California street, San Francisco, Cal., it is announced, proposes to place four new trans Pacific liners in service, each to have accommodations for 300 first, 150 second class and 1,500 steerage passengers.

Tankers, New York.—The Sinclair Consolidated Oil Corporation, 120 Broadway, New York, is in the market for additional tankers. Two large tank ships have recently been placed in service.

Ten 6,000-Ton Vessels and Three Passenger Steamers, London.—Lord & Curtis, 32 Regent street, London, are in the market for ten 6,000-ton cargo steamers and three passenger steamers from 2,000 to 3,000 tons, according to a cable from the American Attaché at London. If American shipping companies are interested they are asked to cable quotations direct to the firm named.

Three Oil Tankers, Los Angeles, Cal.—The Pan American Petroleum & Transport Company, Los Angeles, Cal., is in the market to place orders for three large oil tankers.

Twenty Steel Three-Masted Schooners, New York.—N. E. McClelland, 2 Stone street, New York, is in the market for unnamed clients for twenty steel three-masted schooners of 850 to 900 deadweight tons each. These vessels will be 165 feet overall, with a beam of 35 feet and molded depth of 14 feet 6 inches. Delivery on these vessels is required in two years' time or less.

Twenty 10,000-Ton Freighters, Seattle, Wash.—It is understood that a man named Moore, Seattle, Wash., has organized a company to build a fleet of twenty freighters of 10,000 tons each.

Two Large Tankers, New York. — The Cities Service Company, 60 Wall street, New York, is in the market for two large tankers of about 10,600 tons.

Two Oil Tankers, New York.—The Vacuum Oil Company, 61 Broadway, New York, is in the market for two large oil tankers.

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NEW SHIPYARDS AND SHIPYARD EXTENSIONS

Drydock, Brooklyn, New York.—The Morse Dry Dock & Repair Company, Brooklyn, New York, now operates a floating drydock equipped to handle 625-foot vessels of over 24,000 tons. When the sixth section is completed, vessels 725 feet long can be accommodated.

Drydock, Clyde, Scotland. — Messrs. Barclay, Curle & Company, Ltd., Whiteinch, are negotiating to build a graving dock at Elderslie on the Clyde. If the permission of the Clyde trustees is granted a drydock 600 feet in length will be constructed. It is rumored that the delay on the part of the trust in giving approval to this plan for new construction may perhaps be due to the fact that the men composing the trust are not anxious to permit the laying out of a rival dock so near to their own proposed installation.

Drydock, Quincy, Mass. — The Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., has awarded a contract to M. M. Davis & Son, Inc., Solomons, Md. to construct ten wooden pontoons, 116 feet long, 41 feet wide and 13½ feet deep, which will be towed to the Fore River yard at Quincy, Mass., where they will form a 10,000-ton drydock. Arrangements have now been completed by which the Commonwealth of Massachusetts will rent to the Bethlehem Shipbuilding Corporation at a nominal rent of $1 per year, 600,000 square feet of land adjoining the premises of the Fore River plant. This opens the way for the construction of a large drydock by that company, which, as previously announced, will cost between $2,000,000 and $4,000,000.

Drydock, Vancouver, B. C.—J. Coughlan, of J. Coughlan & Sons, Vancouver, B. C., has announced that the company is willing to finance the construction of a large graving dock at the port of Vancouver under the Canadian Drydock Subsidy Act. The dock will be operated by the company for repair work.

Marine Manufacturing Building, New York.—Charles Cory & Son, 290 Hudson street, New York, manufacturer of ships' bells and electrically-operated marine apparatus, is preparing to construct a six-story reinforced concrete addition to cost about $200,000.

Marine Manufacturing Company, Syracuse, N. Y.—The Inland Marine Corporation, Syracuse, N. Y., was recently incorporated with a capital stock of $100,000, to manufacture marine equipment. D. E. Alvord, B. E. Shove and M. S. Melvin are the incorporators.

Marine Railways, Dredging, Etc., Tampa, Fla.—The McElroy Engineering Company, Tampa, Fla., holds a contract for work to be carried out for the Winter Haven Lake Boat Course District Commissioners, including the building of two marine railways, dredging, etc.

Pattern Shop, Norfolk, Va.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is planning the construction of a pattern shop at the Norfolk Navy Yard.

Railway Drydocks, Burin, Newfoundland.—The Western Marine Railways, Ltd., has contracted for the construction of two railway timber drydocks at Burin, Newfoundland. The larger of these docks will measure 170 feet over the keel blocks, and will be capable of handling vessels up to 1,000 tons displacement. The other drydock will be able to handle two vessels of 300 tons displacement. The Crandall Engineering Company, East Boston, Mass., will design and construct these railways.

Railway Drydock, Baltimore, Md.—The Union Shipbuilding Company, Baltimore, Md., is about ready to be in the construction of a railway drydock capable of handling vessels up to 4,000 tons displacement. This drydock will be 316 feet over the keel blocks with a draft of 20 feet. The Crandall Engineering Company, East Boston, Mass., has designed the dock and will superintend the work.

Sheet Metal Products for Drydocks, New York.—The Drydock Sheet Metal Works, 140 West 42nd street, New York, has acquired property at 509 East 80th street. The company plans to construct a new three-story plant on the tract.

Shipbuilding Company, Alberni, B. C.—The Port Alberni Shipbuilding Company, Ltd., has recently been organized with a capital of $100,000 for shipbuilding purposes. The registered office is given as Alberni, B. C.

Shipbuilding Company, Dublin, Ireland.—The Irish Shipbuilders, Ltd., a new shipbuilding corporation located at Dublin, Ireland, has booked two orders from a Belfast concern. The yard which is seven acres in extent includes five shipways, three of which will accommodate 300-foot vessels.

Shipbuilding Company, New York. — The Monofer Shipbuilding Company, New York, has recently been incorporated with a capital of $30,000, by J. L. Druck, L. F. Sniffen and F. Kweton, 49 Wall street, to build ships of cast steel, under license of the Cast Steel Ship Corporation, 114 Liberty street, New York.

HARBOR IMPROVEMENTS

Barge Canal Terminal, East River, New York.—The New York State Barge Canal Terminal, costing over a million dollars, has been opened at Pier 6, East River, New York. The appropriation for this construction was available eleven years ago after the passage of the Barge Canal Terminal act which provided for the issuing of $19,800,000 in bonds for the construction of canal terminals.

Bulkhead, Norfolk, Va.—The standard Oil Company is negotiating through City Manager Ashburner, Norfolk, Va., for the construction of a bulkhead at the port by a joint agreement. The whole work will cost the city about $250,000.

Concrete Pier, Bridge and Ferry Slip, Bay Shore and Rock Hall, Md.—The Baltimore & Eastern Shore Ferry Line, S. A. Tubman, vice-president and manager, Room 613 Lexington building, Baltimore, Md., plans to construct a 1,000-foot reinforced concrete pier with bridge and ferry slip at Bay Shore and at Rock Hall, Md. M. D. Swartz, Madison avenue and Preston streets, Baltimore, is the engineer, and the Raymond Concrete Pile Company, Baltimore, is the contractor. The company has also purchased two double ferryboats.

Completion of Army Terminals, Philadelphia, Pa.—The army terminals, located at Philadelphia, Pa., upon which work was begun in August, 1918, will be completed by December 1. These three adjacent piers equipped with the most modern handling and storage facilities had been built at the expenditure of $13,000,000.

Docks, Berkley, Va. — M. Block and L. Shefsky have purchased the Fosburgh Lumber Company, Berkley, Va., and plan to spend about $75,000 in providing docking facilities for large vessels.

Harbor Improvements, Mobile, Ala.—William T. Donnelly, consulting engineer, 17 Battery Place, New York, has submitted a report to the Harbor Board of the State of Alabama, advising the expenditure of $5,000,000 over a five-year period upon part improvements at Mobile. This work, as outlined, would include the building of a 1,240-foot bulkhead for $200,000, the erection of a four-story concrete warehouse for $1,250,000, as initial construction. He advised the building subsequently of 800-foot piers with fireproof sheds at an estimated cost of $1,250,000 each. He recommended that the relocation of railroads be carried out to facilitate freight handling and that all shipping developments be built above the Gulf storm level. Further action will depend upon securing State appropriations for this improvement at Mobile.

Harbor Improvements, Portland, Maine.—At a recent special election the voters of the state of Maine authorized a bond issue of $2,000,000 to be used for a state steamship pier at Portland, Maine, and an interstate bridge across the Piscataqua river.

EQUIPMENT WANTED

Freight Handling Machinery, Portland, Ore.—G. B. Hegardt, chief engineer of the Portland Dock Commission, Portland, Ore., is considering the installation of a system of mechanical freight carriers similar to those in operation at Duluth, Minn.

Freight Handling Machinery, Stapleton, Staten Island, N. Y.—C. J. Hogstett, technical department, Pan-American Terminal and Dock Corporation, Woolworth Building, New York, advises us that this company has distributed blue prints of its two new piers at Stapleton, Staten Island, to machinery manufacturers in order that they might offer suggestions as to the class of machinery best suited for the most efficient handling of freight at this point. No specifications have as yet been issued. This company has stated that it has contemplated an installation of at least 34 cranes.

Machine Shop Machinery, Puget Sound, Wash. — The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., is receiving bids on various kinds of machine shop machinery to be installed at the Puget Sound Navy Yard.

Mechanical Freight Handling Facilities, Gantry Cranes and Special Appliances, New York City.—Isbrandtsen, Moller & Company Woolworth Building, New York City, who have leased two piers from the city of New York, plan to have these piers furnished with all modern mechanical freight facilities, including gantry cranes and special appliances. Distributing and tiering of inbound freight will be handled mechanically.

Motor-Driven Bolt Threading Machine and a Bar-Iron Rivet Shearing Machine, Brooklyn, N. Y.—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., is receiving bids on one motor-driven bolt threading machine and one bar-iron rivet shearing machine, to be installed at the New York Navy Yard, Brooklyn, N. Y.

Tools, Hardware, Concrete Machinery, Structural Iron and Steel, Office Supplies, etc., Roumania.—The Belgrade Consulate, K. S. Patton, consul, Belgrade, Roumania, seeks catalogues of tools, hardware, concrete machinery, structural iron and steel, office supplies electrical equipment and machine tools.

SURPLUS MATERIAL FOR SALE BY GOVERNMENT

Sheets, Plates, Shapes, Bars and Fabricated Structural Material.—The United States Shipping Board Emergency Fleet Corporation, 140 North Broad street, Philadelphia, Pa., requests bids on 3,000 tons of sheets, 7,000 tons of shapes, 20,000 tons of plates and 2,500 tons of bars. Details can be obtained from the above offices or at the district sales offices of the Supply and Sales Division.

Ship Machinery, Boilers, Steel Shapes, etc.—The United States Shipping Board Emergency Fleet Corporation, Washington, D. C., has for sale at its warehouse, surplus ship building materials, including machinery, boilers, deck machinery and equipment, valves and fittings, electrical equipment, refrigerating outfits, cargo handling machinery, steel shapes and miscellaneous material. Further information will be supplied by the Sales Section, Supply & Sales Division, United States Shipping Board, 140 North Broad street, Philadelphia, Pa.

Steam Engines, Derricks, etc. — The Director of Sales of the War Department announces that the Surplus Property Division of the office of the Quartermaster General is offering for sale, by negotiation, construction equipment including steam engines, derricks, generator sets, gas engines, steam boilers, etc., valued at $900,000.

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